THREE ESSAYS IN REAL ESTATE AND URBAN ECONOMY

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THREE ESSAYS IN REAL ESTATE AND URBAN ECONOMY

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This dissertation aims to demonstrate applications of regional science methodologies to analyze issues in real estate and urban economics in different scales: city, region, and country. The methodologies used in this dissertation include geographic information systems (GIS), spatial econometrics, and computable general equilibrium (CGE) modeling. There are three chapters in this dissertation.

The first chapter studies the impact of the new mass transit systems on the land values of residential development in Bangkok, Thailand. GIS and spatial econometrics are used to examine the impacts. The study has found that the proximity to mass transit stations spatially correlates with an increase in the prices of residential land. The benefit of new mass transit stations, however, may not be equally distributed to the residents of Bangkok due to the lack of value capture mechanisms such as a capital gain tax or a property tax. Policy implications on property taxation are also discussed in this study.

Chapter two discusses the economic impact of Cornell University on Tompkins County, New York, focusing on the impact of the investment on the new mixed-used development in Collegetown. This study is one of the first attempts to study the economic impact of a university using a CGE model. In addition, the assumption of increasing-returns-to-scale is incorporated into the framework of a small-area CGE model. This extension of the model allows for a more realistic representation of the imperfect competition in the economic simulation.

In the last chapter, a financial CGE model is used to investigate the role of real estate investment in the economy of Thailand. This study discusses how the over-invested real estate market can cause the country to be vulnerable to a financial crisis. In addition, the relationship of real estate asset and property markets is incorporated into the model to captures interconnections between production sectors and financial sectors. The macroeconomic and socioeconomic indicators from the model simulation show that moderate investment in real estate sectors can lead to steady economic growth with small impact on income disparity.

BIOGRAPHICAL SKETCH

Sutee Anantsuksomsri pursued his Doctoral degree in the field of regional science in the Department of City and Regional Planning, Cornell University. His research focuses on urban and regional economics, urban revitalization, and spatial econometrics, and particularly on issues related to housing and real estate development. His areas of specialization also include economic impact studies, Computable General Equilibrium modeling, and Geographical Information Systems (GIS).

At Cornell, he taught a GIS course to students in Urban and Regional Studies and in the Cornell Institute for Public Affairs in Spring 2012. He was also a teaching assistant of several undergraduate- and graduate-level courses in quantitative methods, planning, and policy analysis. From 2009 to 2011, he taught several GIS workshops for the Cornell Program in Real Estate. In addition, he has conducted numerous research projects including the Cornell Economic Impact Studies and geovisualization of economic data. He has been a researcher for the Program on Applied Demographics, analyzing regional socioeconomic and demographic-related issues in New York State.

Anantsuksomsri received his Bachelor of Landscape Architecture from Chulalongkorn University, Thailand in 2002, his Master of Science in Construction Management from Northeastern University, Boston in 2006, and Master of Arts in Regional Science from Cornell University in 2011. In addition, he has professional experience as a landscape architect, real estate developer, and planner, in Thailand and the United States. Born in Bangkok, Thailand, he is married to Nij Tontisirin.

To the love of my life, Nij Tontisirin

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CHAPTER 1

A SPATIAL ANALYSIS OF THE IMPACT OF MASS TRANSIT IMPROVEMENTS ON RESIDENTIAL LAND DEVELOPMENT VALUES IN THE BANGKOK METROPOLITAN REGION

1.1 Introduction

Within the past two centuries, the urban area of Bangkok has been growing from the settlement on the bank of Chao Phraya River to one of the major metropolitan areas in Asia. The Bangkok Metropolitan Region (BMR) covers an area of 7,761.66 square kilometers (2,996.79 square miles) including 6 provinces, namely, Bangkok, Nonthaburi, Nakhon Pathom, Pathum Thani, Samut Prakan, and Samut Sakhon (See Figure 1.1). As of January 2010, the BMR has an estimated population of 14,565,547 and a population density of 1,876.60 per square kilometer (4,860.38 per square miles). As shown in Figure 1.2, since the 1960s, its urban structure has been rapidly expanded due to the first Thailand national development plan.

In order to improve the quality of life and stimulate economic growth, a large amount of government expenditure has been invested in public infrastructure such as road networks, mass transit systems, and utilities. However, urbanized areas have grown without effective control from the government, while housing development in the city has been led mainly by real estate developers. Consequently, the urban areas of the BMR have expanded along major road networks, resulting in strip developments, especially in the outskirts of the region. BMR's freeways have been major paths for people to commute to the city center. As a result, traffic congestion has become one of the most crucial problems of the city since the transportation policies in the past concentrated mostly on construction of new roads, rather than on traffic management.

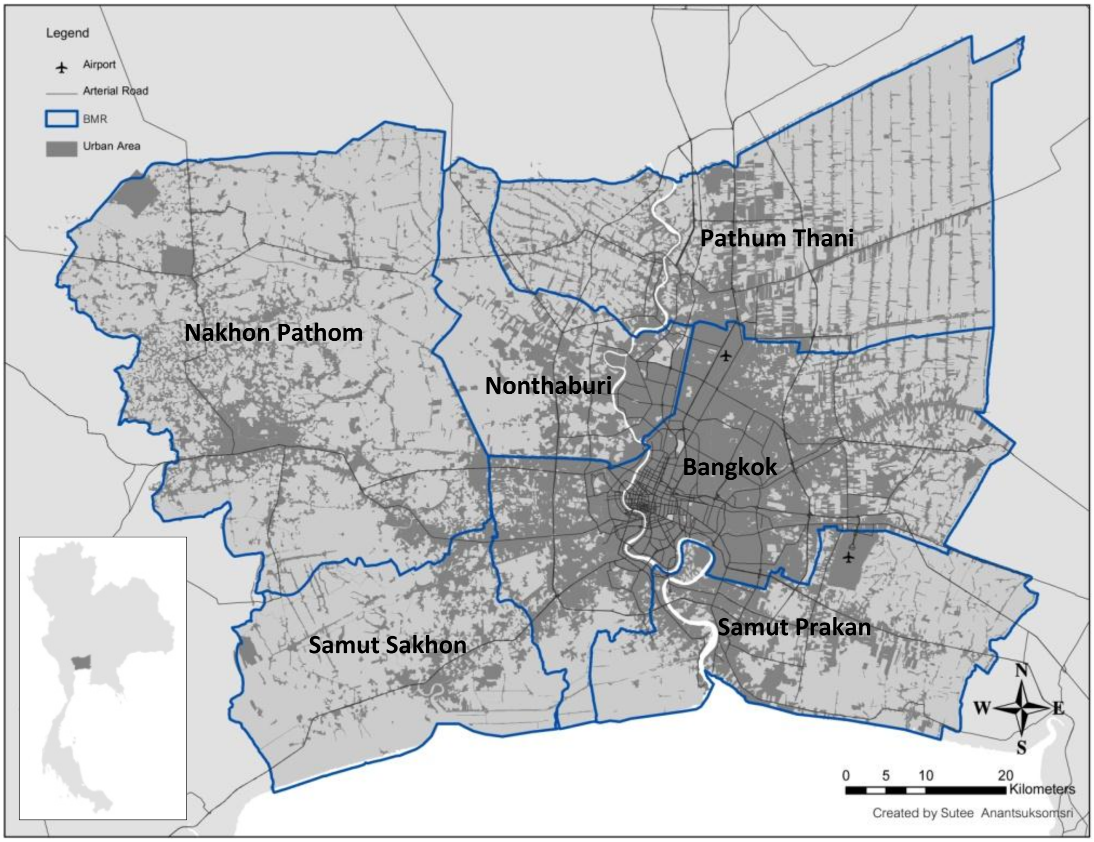
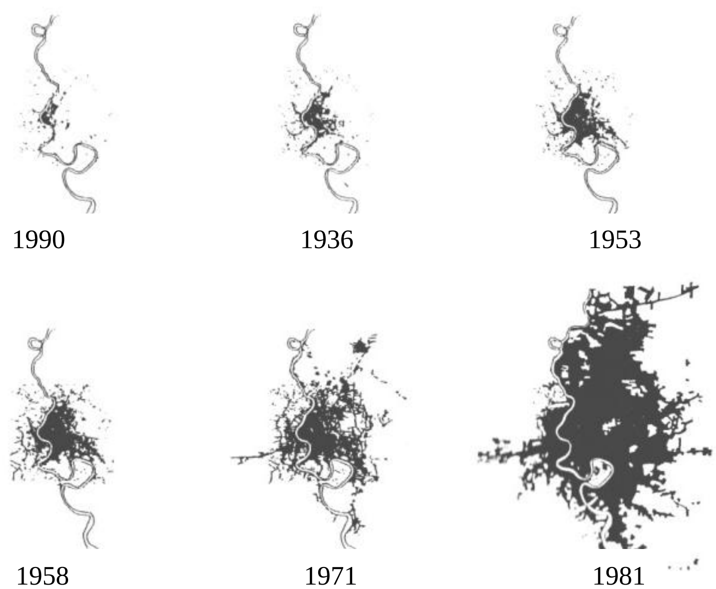


Figure 1.1: The Bangkok Metropolitan Region (BMR) in 2010



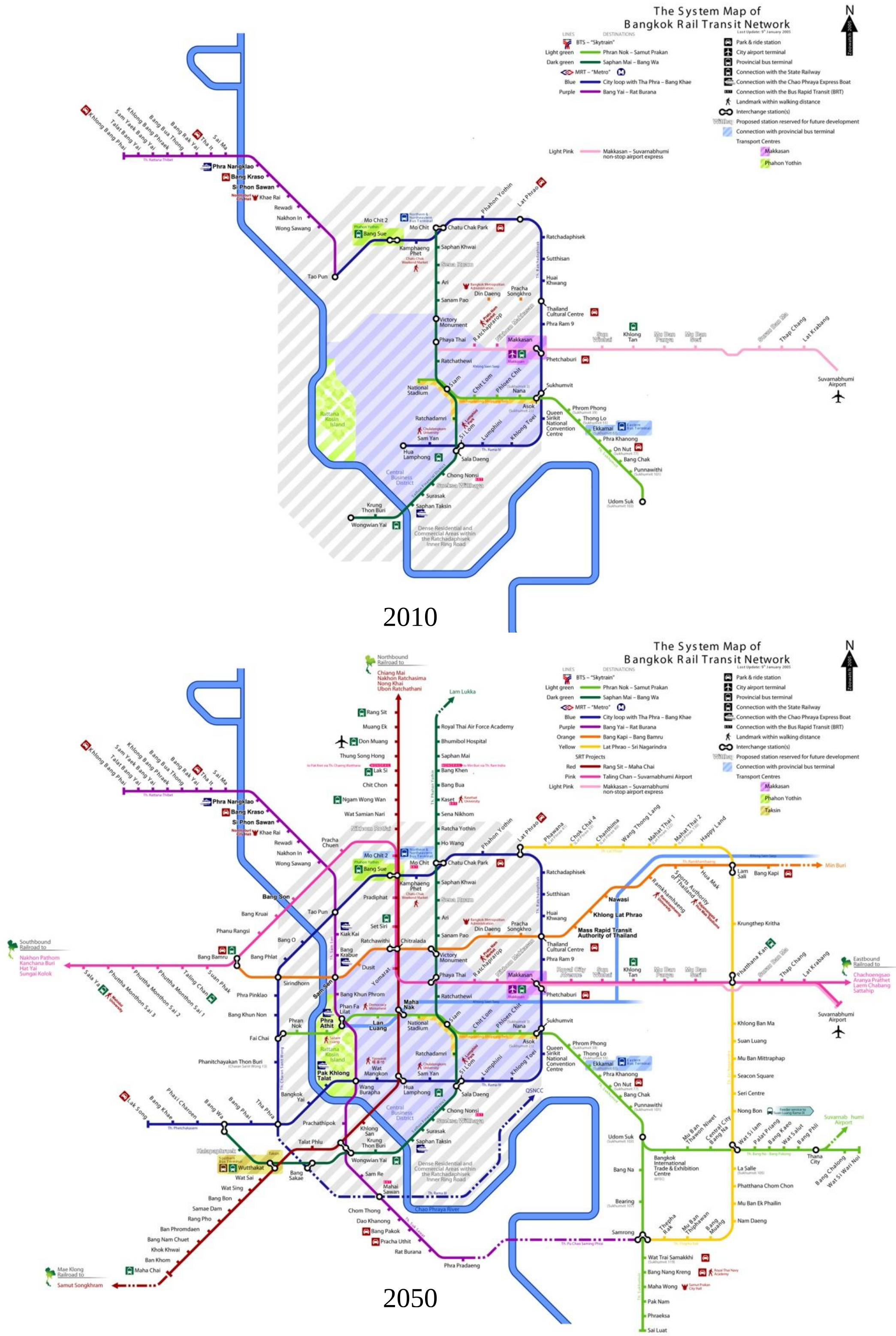
Source: JICA (1991)

Figure 1.2: The urban area of the BMR from 1900 to 1981

In order to ease the chronic traffic congestion in the BMR, a rapid transit project was initiated in the early 1990s. However, due to political interference and economic problems, the processes of planning and construction of the rail system had been slowly implemented. Not until the late 1990s, the first mass transit system in Bangkok, the Bangkok Mass Transit System (BTS) Skytrain was introduced. Soon after, the Mass Rapid Transit (MRT) Subway started operations in 2004. These mass transit systems have not only alleviated traffic problems, but also assisted economic development and shaped the urban structure of the BMR.

As of 2011, there are three mass transit systems in the BMR: BTS Skytrain, MRT Subway, and Airport Link, which started its operation in August 2010, linking the Suvarnabhumi International Airport to the city center. Moreover, the MRT Purple Line is now under construction and expected to be operational in 2014. The current transit systems, however, are quite limited within the city center, covering about 71.5 kilometers (44.4 miles) in length, which makes only one sixth of the entire plan. Figure 1.3 shows the current network of mass transit systems in 2010 and the full network which is expected to be completed in 2050, consisting of 12 transit lines and covering around 495 kilometers (307.58 miles) in length (Nara, 2004; Office of Transport and Traffic Policy and Planning, 2009).

Since the 1960s, Bangkok urban form has been characterized by automobile-oriented transportation and urban sprawl toward its periphery. Since the emergence of the mass transit in the early 2000's, Bangkok urban development has intensified, especially in the inner areas where the mass transit is accessible. A great number of new residential developments, for example, can be seen along mass transit routes. Like the impact of road improvement, the impact of the rapid transit system may affect values of lands in the city, resulting in greater disparities in land prices between land parcels located on and away from mass transit stations.



Source: adapted from Chatchawal Phansopa (www.2bangkok.com)

Figure 1.3: The mass transit systems in the BMR in 2010 and 2050

The great disparities in land prices between land parcels located near and away from urban amenities and infrastructures have been created not always positively. The prices of lands in Bangkok and its vicinity have been dramatically increased, yet benefiting only a handful of the urban rich, land lords, and real estate speculators. This phenomenon is one of major factors contributing to increasing inequality in the BMR. These well-off people have received great benefits such as higher land value from public infrastructure investment while other people like the urban poor have to bear higher cost of rent. These phenomena can be explained by the concepts of economic rent, rent, and value capture which have not been well understood by many stakeholders such as communities, planners, policy makers, and politicians involving in regional and urban planning in Thailand.

In this chapter, the analysis of current housing and real estate developments in the BMR will reveal the evidence of changes in residential land value and pattern of urban structure with the impacts of existing and proposed rapid transit systems. The result of this study can also be used as guidance for urban policies such as urban development plans and land taxation. In addition, this research will be one of the first attempts to examine the spatial relations of the public transit and residential development in the full coverage of the BMR using the spatial analysis methods.

1.2 Literature Reviews

1.2.1 Hedonic Modeling

Hedonic modeling has been extensively applied to evaluate and assess a property value based on its constituent attributes. These attributes can be generally characterized into three board categories: (1) physical or structural attributes, (2) neighborhood or environmental attributes, and (3) accessibility attributes including distances to roads, transportation, amenities, and workplaces (Baumont, 2009). The theory of hedonic models stemmed from the framework of Lancaster (1966) and Rosen (1974). Fundamentally, hedonic regression models decompose property's individual component characteristics and support inferences of their contributory values. In addition to property valuation, the models are also widely used in property taxation and land use planning (Löchl, 2010). In general, hedonic models can be defined in linear or non-linear forms. The simplest form of hedonic models is ordinary least square (OLS) which can be defined as follows:

$$Y = X\beta + \varepsilon, \tag{1}$$

where Y is an N x 1 vector of property values,

X is an N x K matrix of explanatory variables,

β is a K x 1 vector of a coefficient of explanatory variables, and

ε is an N x 1 vector of random errors.

1.2.2 Spatial Hedonic Modeling

Besides physical attributes of a property, one of the most important factors determining a property value is its location. The location not just defines the quality and characteristics of its neighborhood and surrounding environment but also the levels of accessibility to public amenities and transportation. If location-related or spatial characteristics are ignored, the estimation coefficients of a hedonic model may be inefficient and inconsistent (Wilhelmsson, 2002). The conclusions drawn from such analyses could be inaccurate or even misleading (Anselin & Bera, 1998). Hence, it is important to take spatial attributes into account when analyzing property values.

The traditional OLS estimation, which ignores the presence of geographical attributes, may not be appropriate for property valuation if spatial effects are identified. These spatial effects are categorized broadly into two types: spatial dependence and spatial heterogeneity. According to Anselin (1999), spatial dependence (spatial autocorrelation) is “the coincidence of value similarity with locational similarity” (for detail discussion about spatial autocorrelation, see Anselin, 1988, 1999). For example, the value of a certain property is likely to be correlated with its nearby properties. Spatial heterogeneity, on the other hand, is the variation in space of value due to location specific characteristics. It arises from locational differentiation of the data, implying structural instability in the form of non-constant error variances or model coefficients (Anselin, 1999).

To identify spatial effects, Moran’s I is one of the statistics used to evaluated spatial autocorrelation. The structure of Moran’s I statistic (Anselin, 1993) can be written as follows:

$$I = \frac{\varepsilon' W \varepsilon}{\varepsilon' \varepsilon}, \tag{2}$$

where I is Moran’s I statistic,

ε is an N x 1 vector of random errors,

W is an N x N matrix of spatial weights matrix representing relationship among dependent variables, and

N is the number of observations.

Since the Moran’s I statistic is a function of a spatial weight matrix. The specification of the weight matrix is crucial in determining the existence of spatial autocorrelation. Generally, there are four criteria for specifying a spatial weights matrix, W:

(1) Adjacency where w_{ij} = 1 if the observation i is adjacent to observation j; w_{ij} = 0 otherwise,

(2) k-Nearest Neighbors where w_{ij} = 1 if the observation i is among the k nearest neighbors of observation j; w_{ij} = 0 otherwise,

(3) Distance where w_{ij} = 1 if the observation i is within the distance d of observation j; w_{ij} = 0 otherwise, and

(4) Generalized Distance where $w_{ij} = d_{ij}$-a where d_{ij} is the distance between i and j and a is a constant.

If the presence of spatial autocorrelation does exist, an OLS model has to be modified in order to deal with spatial effects. The general form of spatial model can be written formally as follows (Anselin, 1988):

$$Y = \rho W_1 Y + X\beta + \varepsilon, \tag{3}$$

$$\varepsilon = \lambda W_2 \varepsilon + \zeta, \tag{4}$$

where ρ is the autoregressive coefficient of the spatial weights matrix, W_1,

λ is the autoregressive coefficient of the spatial weights matrix, W_2, and

ζ is a vector of well-behaved random errors.

In a standard OLS regression model, spatial dependence can be accounted for in two ways: spatially lag and spatial error models (Anselin, 1999). The first method is known as a spatial lag model. It assumes that spatial autocorrelation is in the dependent variable. As W_2 in Equation (4) becomes zero in the general form of spatial model, the error term becomes well-behaved white noise. Equations (3) and (4) reduce to:

$$Y = \rho WY + X\beta + \varepsilon \tag{5}$$

and Equation (5) is equivalent to

$$Y = (I - \rho W)^{-1} X\beta + (I - \rho W)^{-1} \varepsilon \tag{6}$$

The second method is known as a spatial error model assuming that spatial autocorrelation is presented in the error structure. As W_1 in Equation (3) becomes zero in the general form of the spatial model, the error term becomes autocorrelated. Equations (3) and (4) reduce to:

$$Y = X\beta + \varepsilon \tag{7}$$

$$\varepsilon = \lambda W\varepsilon + \zeta \tag{8}$$

By substituting the error term on (8) in (7), the spatial error model is

$$Y = X\beta + (I - \lambda W)^{-1}\zeta \tag{9}$$

Although both spatial lag and spatial error models have been established on strong theoretical grounds and have been widely used in many econometric studies, the discrepancy in the two models—in terms of a general understanding of the models themselves—is rather subtle. Since the spatially weighted dependent variable is entered as an explanatory variable, a spatial lag model is an appropriate tool when capturing neighborhood spillover effects. A Spatial error model, on the other hand, is typically not motivated by a theoretical economic model, but instead is formulated to deal with correlation problems that have emerged from the cross-sectional nature of the data, not necessarily the "spatial" nature of the model (Anselin, 2005).

1.2.3 Studies of an impact of mass transit systems on property values

Spatial hedonic models have been widely used in a study of an impact of mass transit systems on property values (So, Tse, & Ganesan, 1997; Haider & Miller, 2000; Bae, Jun, & Park, 2003; Armstrong & Rodríguez, 2006; Celik & Yankaya, 2006; Chalermpong, 2007; Agostini & Palmucci, 2008). However, there are very few hedonic studies of the effect of transit accessibility on the residential property market in developing counties. Charlermpong (2007) suggests two main reasons why this is so: (1) the limitation of transit investments in developing countries and (2) the lack of available and reliable data.

As shown in Table 1.1, Charlermpong summarizes the relevant studies on hedonic modeling and accessibility premiums in cities outside North America and Europe. Most of the reviewed studies use the Euclidean or straight-line distance from a property location to the nearest transit station as a measure of accessibility. In a linear regression model, the coefficient of the distance can be interpreted as the price premium of being located closer to a transit station. The coefficient is expected to be negative, meaning that the longer the distance, the lower the property value. However, in case of a log-linear model, the coefficient can be interpreted as price elasticity with respect to the change in distance.

In the case of Bangkok, Charlermpong studies relationships of BTS stations and property prices in the inner city of Bangkok, using 226 observations of the prices of pre-owned properties gathered from advertisements in magazines from September 2004 to March 2005. He finds that a property price gradient decreases at approximately US$ 10 per square meter (or approximately US$ 1 per square foot) of livable areas for an additional meter away from BTS stations, and indicates that price elasticity of distance is -0.09.

Table 1.1: Summary of hedonic studies outside North America and Europe

Author (Publication Year)	**Study Area Country**	**Accessibility Premium** (Distance to nearest station)
Chalermpong (2007)	Bangkok, Thailand	$10 per meter Elasticity: −0.09
Celik and Yankaya (2006)	Izmir, Turkey	$4.76 to $18.70 per meter Elasticity: −0.00011 to −0.00058
Agostini and Palmucci (2008)	Santiago, Chile	$2 to $4.57 per meter
Bae et al. (2003)	Seoul, South Korea	3% per kilometer Elasticity: −0.16 to −0.22
So et al. (1997)	Hong Kong, China	3.3% (if a property is located within 10-min walking distance of station)

Source: Charlermpong (2007)

1.2.4 Inequality caused by public infrastructures

Glaeser, Resseger, and Tobio (2009) state that people living in unequal cities tend to be unhappy. They claim that inequality in a city can create higher crime rates, negative effects to the growth of city-level income and population. Urban inequality can stem from several causes such as human capital (Glaeser et al, 2009), and public infrastructures (Calderón & Serven, 2004; Estache, 2006). In developing countries, one of the primary causes of inequality stems from the accessibility to public infrastructure. Ratanawaraha (2010) studies the urban inequality in Bangkok, Thailand. He finds evidences of economic rent seeking activities created from public infrastructure in the areas around Suvarnabhumi Airport, the new international airport in the BMR. He finds that only some groups of people receive benefits from urban infrastructure investment in Thailand.

The concept of rent seeking was originated by Gordon Tullock in 1967. Economic rent seeking starts with economic intervention by government biased toward special interests. Politicians and policy makers create economic rents by rewarding special interests with favored treatment or burdening their competitors with restrictions. This activity is the result of poor transparency and bad governance in development plans. It not only increases the cost of development and investment but also creates uneven distribution of public improvement. Only some groups of people received benefits from higher land value. In the case of land value, theoretically, a value of land increased by urban infrastructures, which are invested by taxes or public money, should be paid back to the society because it is unearned increment or an additional value that is not created from personal investment. It is, however, not the case in Thailand.

Ratanawaraha (2010) finds that there are two major activities of economic rent seeking in Thailand:

(1) *Economic rent seeking at the operational level*

Construction contractors or consultants bribe governmental officers in order to be the contractors or consultants of public improvement projects. This activity increases the cost of the project and decreases economic efficiency.

(2) *Economic rent seeking at the policy making level*

The executive officers or policy makers who have accessibility to the information of public investment projects acquire the lands around the sites before the projects started. By doing this, they are able to receive benefit from compensation from expropriated lands and from increased values of lands near the projects. These policy makers can also have an influence on locations of projects to be on their land or favored locations of their business partners. This activity not only increases wealth of land lords without returns to the society but also raises value of lands and other goods and services.

In the developed country with property tax mechanism, land owners who receive higher land value have to pay back to the society in the form of taxes and fees such as capital gains taxes, betterment taxes, and development fees. In Thailand, however, the mechanism of value capture taxation is not well developed resulting in unfairness between land owners who gain higher land value and tax payers who pay for public investments. In this chapter, the application framework for property mechanism on residential land taxation is presented and discussed in the policy implication in the later section.

1.3 Data

In this study, the database for spatial hedonic regression is drawn from two major data sets: residential land prices from the Real Estate Information Center

(REIC) and geographic information systems (GIS) data from the Department of Public Works and Town & Country Planning. The data from the REIC are market prices of residential lands in real estate projects in the BMR. This study uses market prices instead of official appraisal property values for many reasons. In Thailand, the access to official database of property value from the department of land is limited to the public due to confidentiality concerns. Furthermore, the property value database may not be reliable since the data are sometimes based on an outdated property appraisal value. Rather, a transaction value or a market price is more appropriate to represent a real value of land and a better indicator for evaluating value changes in residential land use. Thus, the data used in this study are market prices rather than official appraisal prices.

1.3.1 Residential Land Price

The data of all single-family residential development projects in Thailand are collected by the REIC, which is operated under the supervision of the Government Housing Bank. In 2010, there were 684 on-market residential real estate projects in the BMR. The data set of real estate projects from REIC includes developers' names, locations, property prices, land prices, number of housing units, number of units sold average housing areas, and average land areas. In Thailand, the unit of land area is measured in a unit called "Tarang Wah" or square wah, which is approximately four square meters or 43.0556 square feet or 0.000988 acre.

The descriptive statistics of the attributes of residential development projects in the BMR are shown in Table 1.2. While the average prices of property in the data range from 190,000 Baht (US$ 6,333) to 79,500,000 Baht (US$ 2,650,000), the average prices of land in the data range from 3,000 Baht per square wah (US$ 2.32 per square foot) to 217,500 Baht per square wah (US$ 168 per square foot). [1] The average land price is 35,110 Baht per square wah (US$ 27.18 per square feet). The distribution of average land price per square wah in the BMR is shown in Figure 1.4.

The real estate projects in the BMR generally are developed by various types of developers, ranging from an entrepreneur who invests his personal investment to finance his small-scale project to an international public company investing in multi-unit projects. As can be seen in Table 1.2, the number of units in a project ranges from four units to 1,465 units. The usable area or house area and land area represent a variety of residential products from a compact townhouse on a small plot of land to a spacious mansion on a large plot of land. The average house and land areas are 53 square meters (412.62 square feet) and 164 square wah (7,061.84 square feet or 0.16 acre), respectively.

Figure 1.5 illustrates the prices of single-family residential land development projects in 2010 in the BMR. The average price of residential land in a real estate project ranges from under 1,000 Baht per square wah (US$ 0.77 per square foot) to more than 150,000 Baht per square wah (US$ 116 per square foot). As shown in the figure, the average price is represented in the range of colors from green (low) to yellow (medium) to red (high).

The spatial distribution of locations of single-family residential projects in 2010 is also shown in Figure 1.5. Most of the residential developments located outside the inner ring road of the BMR; out of 684, only five projects located within the inner ring road. As shown in Figure 1.5, the clusters of residential projects can be visually observed along the outer ring road, especially in the eastern and western areas of the BMR. The cluster of high price of land can be found in the east outside the inner ring road.

[1] The exchange rate in this study: $US 1= 30 Baht (source: Bank of Thailand)

As mentioned earlier about the availability and reliability of the database from the department of land, the data used in this study are of the transaction prices of residential land development. The observations in the data set are average prices of land in residential land development projects which comprise the subpopulation of all residential real estate projects in the market in the BMR in 2010. In addition, REIC reports that newly-built residential property transactions accounted for 70% of all residential transaction in the BMR in 2010. Thus, residential land values in this dataset are representative of residential land values in the city.

Table 1.2: The descriptive statistics of REIC data in 2010

Number of Observation	684				
Variables	Median	Mean	Std. Dev	Min	Max
Property price (Baht)	2,890,000	4,014,281	5,663,603	190,000	79,500,000
Land price (Baht)	30,000	35,110	19,876	3,000	217,500
Number of housing unit	76	117	136	4	1,465
Number of unit sold	42	75	107	0	1,453
House area (sq.m.)	42	53	49	35	650
Land area (sq.wah.)	150	164	90	18	815

Source: Real Estate Information Center

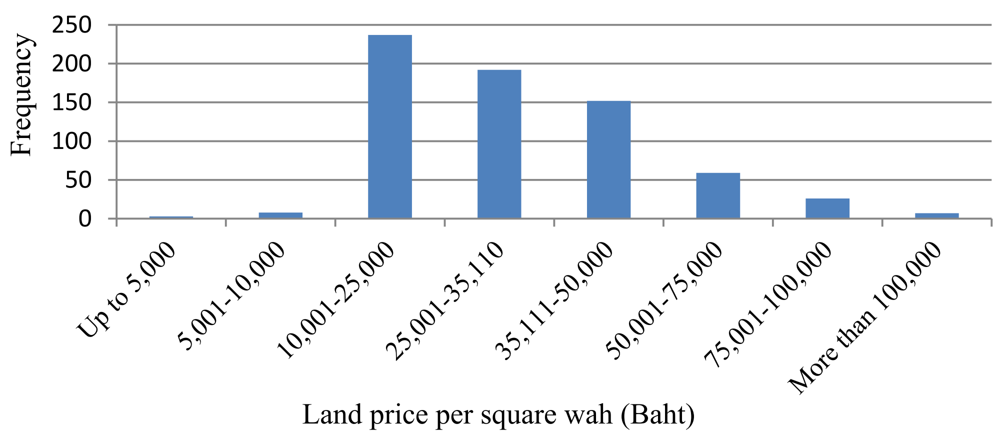


Figure 1.4: The distribution of average land price per square wah

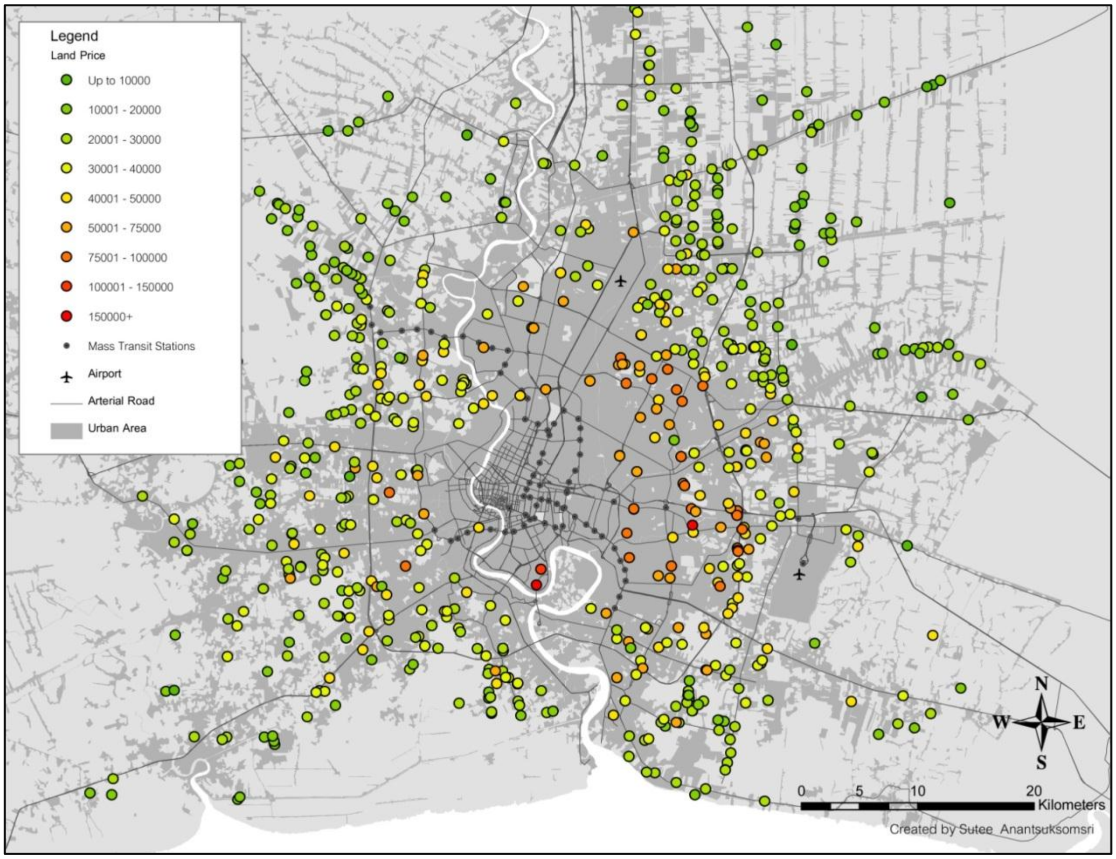


Figure 1.5: The spatial distribution of land price of single-family residential development projects in the BMR in 2010

1.3.2 GIS data of the BMR

The GIS data of the BMR are collected by the Department of Public Works and Town & Country Planning, Ministry of Interior and the Department of City Planning, Bangkok Metropolitan Administrative. The data include the locations of urban infrastructures and amenities in the BMR such as road networks, mass transit stations, airports, hospitals, public parks, top schools, universities, and shopping malls. With GIS data, population density is calculated at the sub-district level, as well as all the distance variables, in ArcGIS® software by Esri. As shown in Figure1.6, most of residential projects are located in sub-districts with high population density represented in darker yellow colors. The density of population can also represent the density of public infrastructures in the BMR.

Table 1.3 summarizes the descriptive statistics of single-family residential real estate development projects, population density in a sub-district where the project is located, and distances from the project to public amenities in the BMR in 2010. The average population density of these sub-districts is 951 people per square kilometer. The lowest population density, 8 people per square kilometer, is at the sub-district of Khlong Song, Khong Luang, Pathum Thani, and the highest population density, 3,666 people per square kilometer, is at the sub-district of Si Gun, Don Mueang, Bangkok. The range of the population density is very wide since the BMR by definition includes the low-populated agricultural areas in Pathum Thani and high-populated residential and commercial areas in Bangkok.

The central business district (CBD) is usually referred to as the area in the subdistrict of Lumphini. In this study, the CBD is located at the southeast corner of Lumphini Park at the intersection of Rama IV Road and Ratchadamri Road. As mentioned earlier, most of single-family residential projects are located outside the inner ring road. The average distance from a project to the CBD is approximately 23 kilometers (or 14.5 miles).

The distribution of land price by distance to the city center in Figure 1.7 also illustrates a land parcel located further from the city center has lower price. The slope of land price has decreased gradually from the city center, supporting earlier findings the Bangkok is a monocentric city (Wisaweisuan, 2001). However, there are two small spikes at the ranges of 11 to 13 kilometers (6.8 to 8.08 miles) and 35 to 45 kilometers (21.75 to 27.96 miles) away from the city center. The slope of land price in this figure conforms to the actual physical configuration of the inner and outer ring roads which are located at approximately 12 and 40 kilometers (7.46 and 24.85 miles) from the city center.

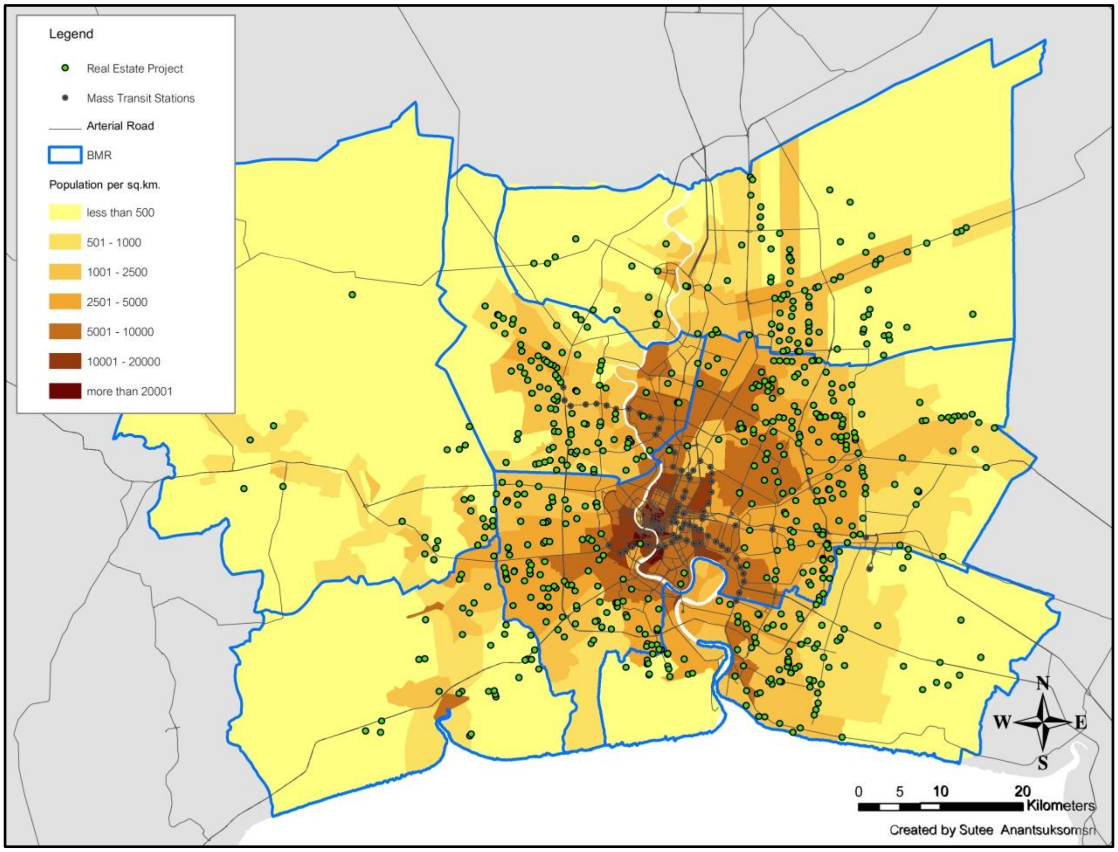


Figure1.6: Population density in the BMR

Table 1.3: The descriptive statistics of residential projects in the BMR in 2010

Number of Observation 684

Variables	Median	Mean	Std. Dev	Min	Max
Land price	30,000	35,330	20,716	3,000	217,500
Number of housing unit	76	117	136	4	1,465
Population density	853	951	716	8	3,666
Distance to					
CBD	22,011	23,374	9,006	3,655	65,140
Arterial road	1,057	1,427	1,486	1	10,144
Mass transit station	10,627	11,875	8,107	222	46,141
Airport	31,212	30,478	14,391	4,492	88,701
Hospital	2,871	3,717	3,764	58	35,535
Public park	3,952	5,231	4,841	111	46,767
Top school	2,951	4,016	4,217	190	44,491
University	6,130	7,019	5,046	616	47,260

As shown in Table 1.3, the average distance from a project to an arterial road is approximately 1.5 kilometer (or about 1 mile). While the closest distance from a project to a major road is 1 meter, the farthest distance is around 10 kilometers (or around 6 miles). The distribution of land price by distance to an arterial road in Figure 1.8 illustrates a land located further from the road has lower price. The slope of land price within the distance of 0 to 5 kilometers (0 to 3.11 miles) is steeper than the slope within the distance of 5 to 7 kilometers (3.11 to 4.35 miles), suggesting that the impact of the road to the land price is high within 5 kilometers. The flat slope within the distance of 5 to 7 kilometers may suggest that the impact is very low. The prices of lands located within these distances are relatively similar.

Figure 1.9 shows that a price of residential land decreases when a land is located away from a mass transit station. The slope of land price is slightly flat within the distance range from 0 to 5 kilometers (0 to 3.11 miles), suggesting that prices of residential land located within approximately15-minute traveling distance of a mass transit station arterial road are relatively similar. The steeper slope with the distance of 5 to 20 kilometers (3.11 to 9.32 miles) may indicate that impact of the proximity to mass transit station to a land price is high. Within these distances, the land price declines sharply when the land is located away from a mass transit station.

As illustrated in Figure 1.10, a price of residential land tends to decrease when the land is located away from urban amenities such as hospital, park, school and university. The price of land adjacent to or located less than 1 kilometer from a hospital or school is lower than the land price located at 1 kilometer away. This may suggest that living too close to a hospital or school is not desirable. On the other hand, the price of land dramatically declines if the land parcel is located farther from a university, especially within the first kilometer. This may suggest that living close to a higher education institute is more preferable than a school.

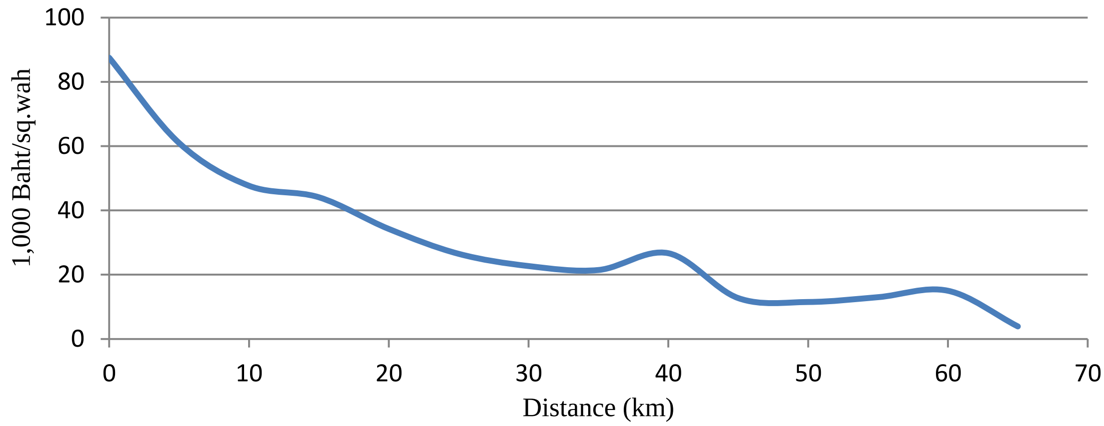


Figure 1.7: Average land price by distance to the city center of the BMR

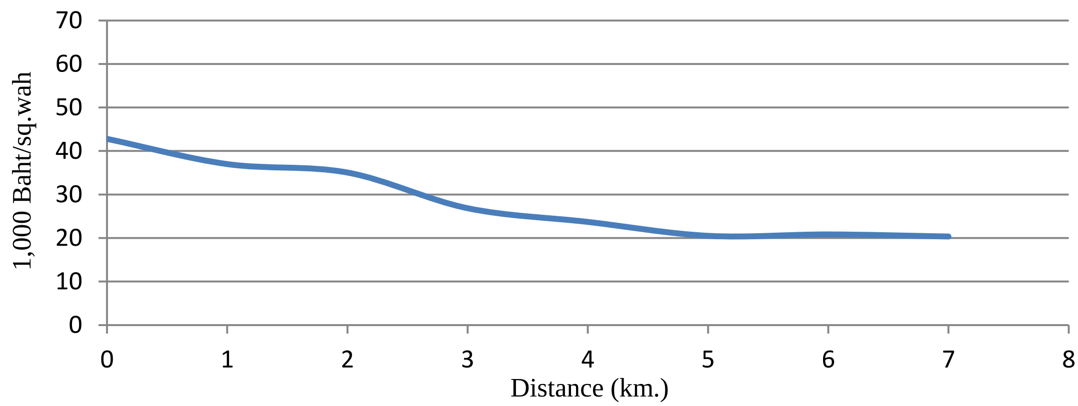


Figure 1.8: Average land price by distance to arterial road in the BMR

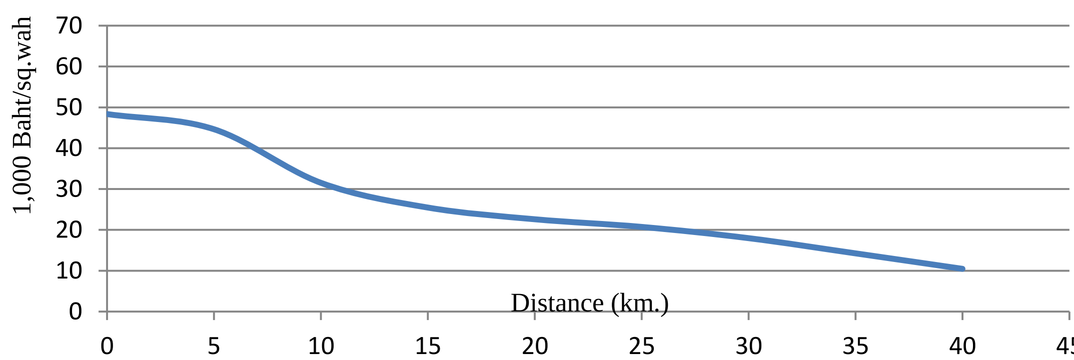


Figure 1.9: Average land price by distance to mass transit station in the BMR

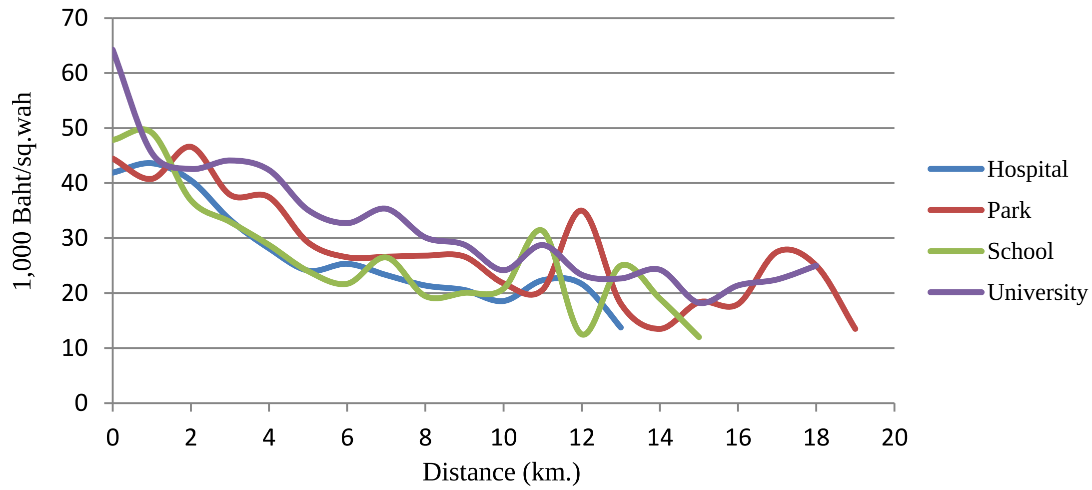


Figure 1.10: Average land price by distance to urban amenities in the BMR

1.4 Methodology

The analysis of land price in the BMR under a hedonic modeling framework begins with model identification and OLS estimation. After the model is identified, spatial autocorrelation is examined. If spatial autocorrelation is found to be significant, spatial hedonic models are employed. The following sections discuss these procedures in detail.

1.4.1 Model specification and OLS estimation

The hedonic OLS model is used as a base model in this study. The dependent variable is land price per square wah. Out of 684 observations, 62 outliers and missing data are excluded, leaving 622 observations for the estimation. The independent variables are categorized into three main groups: (1) real estate project characteristics, (2) location characteristic, and (3) proximity to public infrastructures. The characteristics of real estate projects include number of housing unit, number of unit sold, average house area, and land area. The population density of sub-district in which a real estate project is located is considered as a location characteristic.

Proximity to public infrastructures is measured by Euclidean distance from a location of a real estate project to locations of it nearest public amenities such as a mass transit station, major road, CBD, airport, hospital, public park, top school, and university. These distances may not all be presented in a regression model since it violates the *ceteris paribus* assumption. Thus, only the distance to the nearest mass transit station is used as a continuous distance. The other distances are classifies into distance bands based on the distribution of proximity to each type of public amenities.

The proximity to the nearest arterial road is categorized into five distance bands: (1) less than 100 meters, (2) between 100 to 500 meters, (3) between 500 to 1000 meters, (4) between 1 to 5 kilometers, and (5) farther than 5 kilometers. On the other hand, the range of distances to the CBD and the nearest airport, hospital, public park, top school, and university is wider than the proximity to the nearest arterial road. The distances to the nearest hospital, park, school, and university are grouped into three distance bands: (1) less than 1 kilometer, (2) between 1 to 5 kilometers, and (3) farther than 5 kilometers. In addition, the proximity to the CBD and the nearest airport is divided into three distance bands: (1) less than 10 kilometer, (2) between 10 to 20 kilometers, and (3) farther than 20 kilometers.

The hedonic OLS model is specified as follows:

$$Y = X_1\beta_1 + X_2\beta_2 + X_3\beta_3 + \varepsilon, \tag{10}$$

where Y is an N x 1 vector of land price per square wah,

X_1 is an N x K_1 matrix of real estate project characteristic variables,

β_1 is a K_1 x 1 vector of a coefficient of X_1,

X_2 is an N x K_2 matrix of population density of sub-district in which a real estate project is located,

β_2 is a K_2 x 1 vector of a coefficient of X_2,

X_3 is an N x K_3 matrix of proximity to public infrastructures variables,

β_3 is a K_3 x 1 vector of X_3, and

ε is an N x 1 vector of random errors,

K is a number of explanatory variables ($\mathrm{K}_1 = 4,\ \mathrm{K}_2 = 1,\ \mathrm{K}_3 = 8$), and

N is a number of observation, 622 observations.

Several tests were performed during the model selection process including the Bayesian information criterion (BIC), Akaike's information criterion (AIC), and the test of multicollinearity. The model selection tests suggest the following explanatory variables: (1) distance to the nearest mass transit station, (2) sub-district population density, and dummy variables of distances to (3) arterial road, (4) CBD, (5) airport, (6) hospital, (7) public park, (8) top school, and (9) university. Appendix 1 shows the test result of multicollinearity. None of the variance inflation factor (VIF) of predictor variables is greater than 10, and the average VIF is 2.36, suggesting no serious multicollinearity.

1.4.2 Testing for spatial autocorrelation

In addition to the OLS estimation, the spatial autocorrelation is examined. As illustrated in Figure 1.5, the geographic cluster of land price can be visually inspected. To formally identify the presence of spatial autocorrelation, the significance of Moran's I statistic is tested. While the significance of Moran's I signals the presence of spatial autocorrelation, the magnitude of Moran's I represents the extent of spatial autocorrelation based on the spatial weight matrix. The specified spatial weight matrix criterion that yields the largest value of Moran's I will be selected. In this study, distance (inverse distance) is selected as the criterion for constructing spatial weight matrix since the observations are point locations of residential lands. After multiple significant tests of Moran's I statistic using different distance bands, the result indicates that at 18.8 kilometers (11.68 miles), Moran's I statistic is significant and has the highest magnitude at 0.333 where all observations are included and have at least one neighbor (see Figure 1.11). Thus, the distance is used as a threshold to construct the spatial weight matrix, which will be later used in both spatial lag and spatial error models.

1.4.3 Estimation of spatial hedonic models

The spatial hedonic regressions under taken in this study include spatial lag and spatial error models. To choose the most appropriate model between these two, the hypothesis test of autoregressive coefficients is conducted. In order to test spatial lag dependence, the Lagrange Multiplier (LM) is used to test that the null hypothesis, ρ=0:

$$LM(lag) \; = \; \frac{(\varepsilon\prime WY/\sigma^2)^2}{\frac{(WX\beta)' MWX\beta}{\sigma^2} + tr(W'W + W^2)}, \qquad (11)$$

where M is the projected matrix, $I - (X(X'X) - 1X')$, and $\sigma^2 = \frac{\varepsilon'\varepsilon}{N}$.

In order to test spatial error dependence, the LM is used to test that the null hypothesis, λ=0:

$$LM(error) \; = \; \frac{(\varepsilon\prime WY/\sigma^2)^2}{tr(W'W + W^2)} \qquad (12)$$

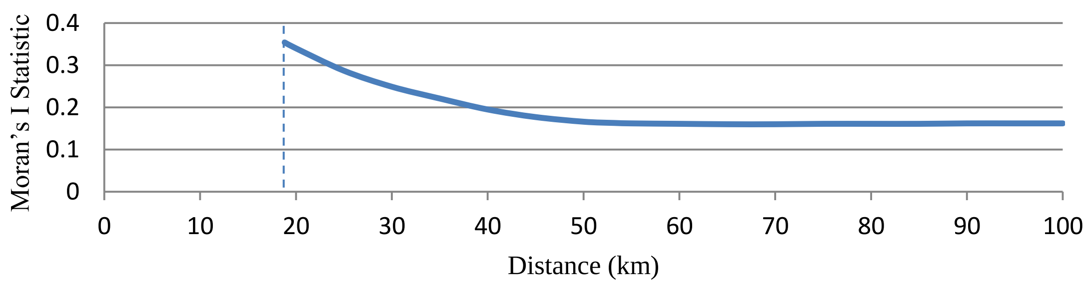


Figure 1.11: Moran's I statistic by distance criterion specified in the spatial weight matrix

Based on the LM test of two models, if one of two statistics is significant, the model with the most significant LM statistic will be selected. In case that neither statistics is significant, the spatial dependence hypothesis is rejected, indicating that the OLS model is good for the hedonic regression. On the other hand, if both statistics are significant, the robust LM statistic test is needed to be performed and compared. The preferred model is the model with larger value of the robust LM statistic (Anselin, Bera, Florax, & Yoon, 1996).

1.5 Result

1.5.1 Regression Models

The results of spatial diagnostics are shown in Table 1.4. As can be seen, both models give significant LMs, indicating the significant presence of spatial autocorrelation. This significance suggests that OLS is not an appropriate model. The result also indicates that only the LM of spatial lag is significant. Thus, the spatial lag model is selected as the preferred model. The regression results of OLS regression, spatial error, and spatial lag models are shown in Table 1.5. Since the robust LMs suggest that spatial lag is the most suitable model, only estimation results from the spatial lag model are discussed.

Table 1.4: The spatial diagnostics

Test	Statistic	df	p-value
Spatial error:			
Lagrange multiplier	16.251	1	0.000
Robust Lagrange multiplier	1.058	1	0.304
Spatial lag:			
Lagrange multiplier	17.667	1	0.000
Robust Lagrange multiplier	2.204	1	0.138

Table 1.5: The regression results

Variables	OLS	Spatial Error	Spatial Lag
Distance to Mass Transit Station	-0.411***	-0.474***	-0.283***
	(0.058)	(0.087)	(0.064)
Population Density	2.595***	2.138***	2.131***
	(0.595)	(0.662)	(0.586)
Dummy of Distance to Arterial Roads			
Less than 100 meters	8443.265 ***	6983.726***	7429.052***
	(1905.466)	(2044.395)	(1857.808)
Between 100 to 500 meters	7097.358***	5787.008***	6137.640***
	(1913.537)	(2061.082)	(1866.119)
Between 500 to 1000 meters	4452.998**	2774.193	3566.739*
	(1900.300)	(2054.863)	(1849.772)
Between 1 to 5 kilometers	2640.653	1114.920	1883.643
	(1742.980)	(1881.614)	(1695.196)
Dummy of Distance to CBD			
Less than 10 kilometers	12796.051***	12056.434***	11113.203***
	(2211.325)	(2449.371)	(2175.249)
Between 10 to 20 kilometers	5158.295***	4728.771***	3928.937***
	(933.190)	(1139.435)	(947.976)
Dummy of Distance to Airport			
Less than 10 kilometers	5406.716***	4229.908**	3180.392**
	(1546.306)	(2043.445)	(1585.027)
Between 10 to 20 kilometers	3844.251***	3507.604***	2507.005**
	(956.391)	(1304.969)	(977.277)
Dummy of Distance to Hospitals			
Less than 1 kilometer	-267.297	850.528	149.670
	(1582.564)	(1698.610)	(1533.775)
Between 1 to 5 kilometers	-813.819	323.944	-435.035
	(1108.061)	(1251.133)	(1075.408)
Dummy of Distance to Park			
Less than 1 kilometer	7621.488***	7994.608***	7348.482***
	(2011.991)	(2075.924)	(1947.016)
Between 1 to 5 kilometers	1611.867*	1690.238*	1486.131
	(938.567)	(1014.831)	(908.244)
Dummy of Distance to School			
Less than 1 kilometer	915.356	365.802	465.250
	(1761.418)	(1831.172)	(1706.907)
Between 1 to 5 kilometers	2137.413**	1803.157	1549.759
	(1070.885)	(1180.072)	(1044.965)

Table 1.5: The regression results (continue)

Variables	OLS	Spatial Error	Spatial Lag
Dummy of Distance to University			
Less than 1 kilometer	12240.245***	11254.946***	11525.787***
	(3622.782)	(3546.535)	(3507.920)
Between 1 to 5 kilometers	3558.953***	3203.856***	2992.450***
	(851.955)	(911.444)	(834.751)
Constant	22477.923***	24848.229***	11266.184***
	(2073.539)	(2655.472)	(3318.492)
λ-Constant		0.499***	
		(0.110)	
σ-Constant		8122.806***	8154.671***
		(232.218)	(231.903)
ρ-Constant			0.388***
			(0.091)
R-squared	0.561		
N	622	622	622

Notes: t-statistics and z-statistics in parentheses
***, **, and * indicate coefficient estimates that are statistically significant at 0.01, 0.05, and 0.1 confidence levels, respectively.

As shown in Table 1.5, the coefficient of the distance to the nearest mass transit station is negative and statistically significant as expected. This coefficient implies that the price per square wah of residential land development decreases at 0.283 Baht per sq.wah (approximately US$ 0.0002 per square foot) for an additional meter away from a mass transit station. In the other words, the value of 1 acre of residential land development (which equals to 1,000 square wah) located at 1 kilometer (0.621 mile) away from a nearest mass transit station will be US$ 9,210 (283,000 Baht) lower that an identical land located adjacent to the mass transit station.

The coefficient of population density is positive and significant. As mentioned earlier, population density can also represent urban infrastructure density. The denser population implies the higher infrastructure improvement. This result confirms that there is a positive effect of urban infrastructure on the value of residential land development. The proximity to public amenities such as major roads, airports, public parks, and universities has a significant positive impact on land values. From the result, the impact is greater as a land located closer to these public amenities.

The coefficients of the dummies of distance to arterial roads are smaller as the distance bands are farther. The impact of locating within 100 meters from the roads is 7,429 Baht per square wah (US$ 5.8 per square feet), while that of 100 to 500 meters is 6,138 Baht per square wah (US$ 4.79 per square feet). In addition, the impact is less significant for the 500 meters to 1 kilometer distance and eventually becomes not significant for a land located more than 1 kilometer away from the road.

Similar to the impact of proximity to major roads, the coefficients of the dummies of distance to airports, public parks, and university become smaller and less significant as a property located farther away from these infrastructures. On the other hand, the impacts of proximity to hospitals and schools are found to be not significant. As mentioned earlier, living too close to a hospital or school may not be desirable to local residents due to induced noises and traffics from their activities.

The results strongly suggest that, in addition to distances to CBD and arterial roads, distances to mass transit stations have significant impacts on the land value of residential developments in the BMR. Undoubtedly, it is the owners of lands adjacent to mass transit stations who enjoy the increase in land values from the capital-intensive public investment on infrastructure, and the benefits from these investments may not be evenly distributed. Since currently there is no tax on residential lands implemented in Thailand, a certain kind of taxation policy that can “capture” these increased values of residential lands should be in effect. Further, as discussed earlier that assessed land values are outdated and unreliable, the procedure of land value assessment currently in use should be adjusted to internalize locational advantages such as proximity to public amenities and public transit stations, thereby reflecting the real values of residential lands.

1.5.2 Policy Implication on Property Tax

Currently, there are two different types of tax levied on property in Thailand: land tax and structures tax. An annual land tax levied on land ownership is very small. In practice, property owners rarely pay it annually. They usually pay it after several years when the amount has accumulated. An annual structures tax is only applied to properties with commercial use. Unlike many developed counties, property tax is not a main source of income for a local government in Thailand. The main income from property is from a property transaction fee, which is incurred whenever a property is bought or sold.

As shown in Table 1.6, there are four potential taxes or fees to be paid in the property transaction. Applicable taxes or fees depend on the details of the transaction. It is also important to note that most of the fees are calculated based on the official assessed value of the property and, as mentioned earlier, this value is usually well below the market value. Following are the descriptions of taxes and fees:

- A transfer fee is based on the appraised value of the property and is normally shared equally between both buyer and seller
- A stamp duty is based on the official appraised value or the contracted price, whichever is highest
- If the seller is a company, a withholding tax (WHT) on the sale of the property is calculated at 1% of the official appraised value or the contracted price, whichever is higher. If the seller is an individual, the WHT is based on the individual's marginal tax rate after deducting from the official appraisal price a standard deduction based on the number of years of ownership

Table 1.6: Current taxes/fees for a property transaction in Thailand

Taxes & Fees	Party normally pays	Amount
1. Transfer fee	Buyer	2% of the registered property value
2. Stamp duty	Seller	0.5% of registered value. Only payable if exempt from business tax
3. Withholding tax	Seller	1% of the appraised property value

In fact, there were several attempts to improve the property tax mechanism in Thailand. These attempts were not approved by the House of Representatives since many politicians are major landlords in the country (Ratanawaraha, 2010). The property taxation mechanism in Thailand is needed to be reengineered. The improved mechanisms of property tax, property gain tax, and special assessment levy need to be implemented. The well-managed taxation structure can not only provide higher income to government but also can control speculation on land value via property gain tax. Further, this taxation mechanism may help lower inequality in the county.

Ratanawaraha (2010) suggests that many developed counties such as Japan and Germany have been successful in using a property gain tax and betterment tax to improve inequality and prevent rent-seeking activities. The city of Boston, for example, imposes a betterment tax on a property gaining benefit from a public improvement. According to the Massachusetts Department of Revenue (2001), “A betterment or special assessment is a special property tax that is permitted where real property within a limited and determinable area receives a special benefit or advantage, other than the general advantage to the community, from the construction of a public improvement.”

There are two basic methods for calculating betterment assessments: the “fixed uniform rate” method and the “uniform unit” method. The “fix uniform rate” applies amount of tax levies to every property owner equally regardless of the size or other attributes of the property (Town of Chelmford, 2008). On the other hand, the “uniform unit” method distributes the tax levies proportionally to the size or other attributes of the property. The timing of the assessment usually corresponds to the completion of the project, and a betterment assessment is a one-time tax which can be paid in one lump sum or in multiple-year apportionment.

The Commonwealth of Massachusetts, for example, is one of the governments that imposes a betterment tax on its residents. If properties located nearby the improvement are specially benefited, all or a portion of the cost of public improvement may be assessed on those properties. For example, the Town of Chelmsford constructs public sewers and imposes a betterment tax on the properties abutting the sewer line. These properties are said to have been improved and thus have higher values. Adopting the “uniform unit” method, the town has distributed the assessment cost of the new public sewer project to every property included in the project, proportionally to the number of sewer unit in the property. A single family residence, for example, has one sewer unit, while a two-family residence would be equivalent to two sewer units.

In this study, to illustrate the mechanism of proposed betterment tax, the estimated parameters from the spatial hedonic regression model are used to calculate the amount of proposed taxation on capital gain from higher value of land as a result of public investment on infrastructures. The area near the proposed mass transit line, State Railway of Thailand (SRT) Dark Red Line, is selected as a case study. The SRT Dark Red Line is a suburban railway system to serve the northern part of the BMR. The length of the system is 26 kilometers. The system is the combination of elevated and on-ground structures, consisting of ten stations: Bang Sue (the mass transit station hub), Chatuchak, Wat Samian Nari, Bangkhen, Thung Song Hong, Lak Si, Kan Kheha, Donmuang, Lak Hok, and Rangsit. The stations and surrounding area will develop the capacity for project of commuter train and northern long-distance train. The construction of the project was approved in 2006 with the budget of 55,220 million Baht (US$ 1,840 million).The specific locations of mass transit stations are now selected. The project is under construction and expected to operate in 2019 (Office of Transit and Traffic Policy and Planning [OTP], 2008).

Following is the procedures on how to implement the spatial hedonic model for estimating a proposed betterment tax:

(1) spatial referencing locations of SRT Dark Red stations, and recalculating distance from land to the nearest stations which include proposed SRT Dark Red Line stations,

(2) estimating a change in land value, assuming that the lands with shorter distance to the nearest station gain higher value, *ceteris paribus*, using parameters from the spatial hedonic model, and

(3) Calculating a betterment tax in the selected area.

The first step is to spatially reference the locations of the new SRT Dark Red stations by transforming the latitude and longitude coordinates of the stations' locations into point features on a map. As shown in Figure 1.12, there are 24,062 residential units in 171 real estate projects locate in the northern part of the BMR in 2010 which will gain higher land values as a result of positive externality from the proposed mass transit line. If the SRT Dark Red Line operates, the proximity to the nearest mass transit station of these projects will become shorter. Thus, the distances to the nearest station for these projects need to be recalculated.

As illustrated in Figure 1.13, as a new Dark Red Line station becomes the nearest stations to these projects, the new distance, d_1, will be shorter than the distance to the existing nearest station, d_0. The values of lands in these projects are expected to be higher due to the shorter distance to the nearest mass transit station, *ceteris paribus*. Therefore, the change in land value is affected only by the change of distance to the nearest station. In the second step, the estimated parameters from the spatial hedonic regression model are used to calculate the amount of a change in land value. Formally, the land value gain from the SRT Dark Red Line can be computed as follows:

$$\Delta Y = (d_1 - d_0)\beta_{Dtransit}, \tag{13}$$

where ΔY is a change in land value per square wah,

d_0 is a distance to the nearest existing mass transit station,

d_1 is a distance to the nearest new mass transit station, and

β_{DM} is a K_1 x 1 vector of a coefficient of X_1.

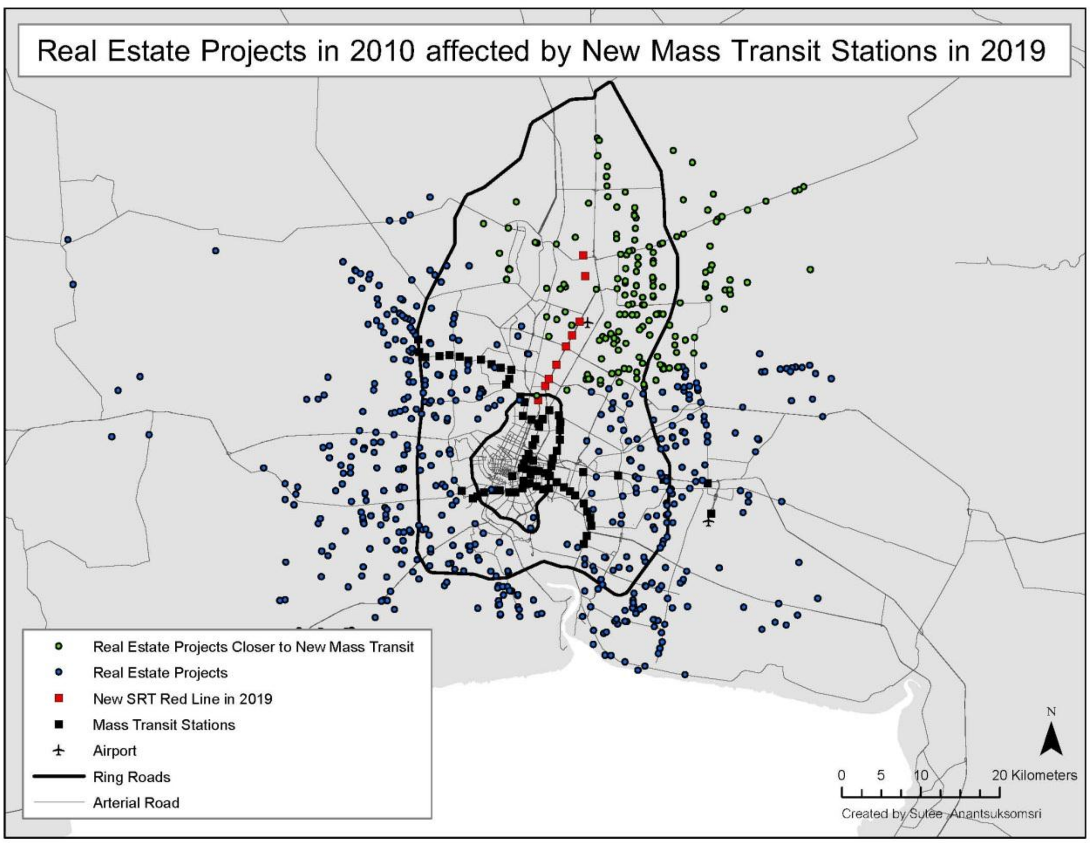


Figure 1.12: The locations of projects affected by SRT Dark Red Line station

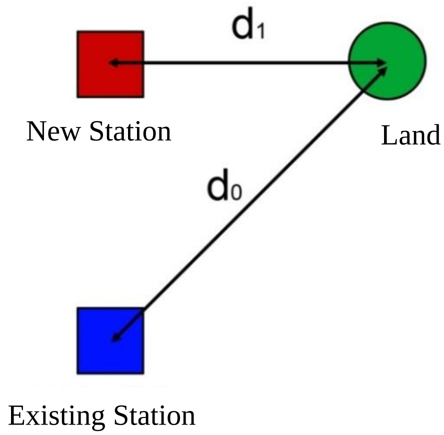


Figure 1.13: A change in proximity to the new mass transit stations from a land

In the last step, the betterment tax is then calculated based on capital gain from increasing land value. The number of residential units in this study, however, is only part of the total housing unit in the selected area. The total capital of the residential lands in real estate projects in the selected area is 2,434 million Baht. This amount of the capital gain is an example of a betterment tax base for single-family residential lands in real estate projects. The appropriate betterment assessment method for this mass transit project is "uniform unit" method that proportionally distributes tax levies to a land area. In practice, determination of betterment levies usually involves agreements among several parties such as government, public infrastructure agencies, residents, and land owners. However, there are controversies around the implementation of a betterment tax since some of public infrastructures such as airports or waste management facilities may not be desirable to every resident. Another controversial issue is the justification for the assessment. Thus, transparency and public participation in the betterment assessment procedures are essential for a successful and effective property tax policy. This betterment tax may be used as one tool to introduce property tax reforms. It is one step toward greater equality in Bangkok and in Thailand at large.

1.6 Conclusion

This study employs spatial hedonic regression model of the land value of residential developments in the Bangkok Metropolitan Region. Among OLS regression, spatial lag, and spatial error models, the spatial lag model is selected as the most preferred model. From the result, it is clear that the mass transit improvement has contributed to an increase in values of residential land development prices. The results of this study have direct implications to property tax policies and land value assessment mechanism.

This study also introduces the implementation of a capital gain tax from higher land value. The scenario of the increasing land value in the area near the proposed SRT Dark Red Line is illustrated as a case study. The parameter estimates can be used to assess a capital gain on land value from public investment on infrastructures given attributes of a property location. The implementation of a betterment tax would not only benefit local and national governments through higher incomes, but also to some extent discourage economic rent seeking or speculative activities. The betterment tax is also one of mechanisms to reduce inequality in the country.

Upon the availability of the data, further studies include examining the effects of proximity to public amenities on land values of different kinds of land use such as commercial and retail uses. In addition, other types of publicly-accessible amenities, for example, police stations and fire stations, should be included as additional explanatory variables. At the end of 2011, Thailand experienced the worst flood in decades, which inflicted millions of Baht in damage. Many provinces in Thailand, including Bangkok, were basically underwater. After this devastating natural disaster, the price of properties in “safe” areas in Bangkok rose considerably, while the price of properties in flooded areas plunged. Therefore, topographical features such as elevation should also be included in the future study.

APPENDIX 1.1

Test of collinearity among explanatory variables

Variable	**VIF**	**1/VIF**
Distance to Mass Transit Station	1.98	0.504283
Population Density	1.48	0.674984
Dummy of Distance to Arterial Roads		
Less than 100 meters	4.5	0.222453
Between 100 to 500 meters	3.95	0.253331
Between 500 to 1000 meters	4.5	0.222206
Between 1 to 5 kilometers	6.63	0.150882
Dummy of Distance to CBD		
Less than 10 kilometers	1.27	0.789251
Between 10 to 20 kilometers	1.7	0.586861
Dummy of Distance to Airport		
Less than 10 kilometers	1.23	0.81333
Between 10 to 20 kilometers	1.29	0.778132
Dummy of Distance to Park		
Less than 1 kilometer	1.37	0.731855
Between 1 to 5 kilometers	1.89	0.529082
Dummy of Distance to Hospitals		
Less than 1 kilometer	1.71	0.585438
Between 1 to 5 kilometers	2.15	0.465289
Dummy of Distance to Schools		
Less than 1 kilometer	2.01	0.498311
Between 1 to 5 kilometers	2.26	0.441603
Dummy of Distance to University		
Less than 1 kilometer	1.1	0.911538
Between 1 to 5 kilometers	1.46	0.683324
Mean VIF	**2.36**	

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CHAPTER 2

DISTRIBUTIONAL IMPACT OF UNIVERSITY-LED REVITALIZATION ON THE NEIGHBORHOOD ECONOMY: A COMPUTABLE GENERAL EQUILIBRIUM MODEL OF A SMALL URBAN AREA

2.1 Introduction

Universities and large institutions can create considerable economic impacts not only on local but also on state economies where they reside. In Tompkins County and New York State, Cornell University has been the generator of economic activities and a cultural center for its community for almost 150 years. As an employer, purchaser of goods and services, investor, and researcher, Cornell University plays a key role in local and state economies. Cornell employed 12,461 workers, accounting for 23.18% of total employment in Tompkins County in 2007. The economic impact from the university on New York State in 2007 was estimated at $3.3 billion, of which $1.7 billion was the impact on central New York (Cornell University, 2007).

Due to its increase and expansion of academic programs and research activities, Cornell has expanded its residential, academic, and research buildings and facilities, thereby affecting the real estate market in the local economy. According to the 2009 Cornell Economic Impact Report, since 2002 its construction investment has increased steadily to $179 million in 2007 (Cornell University, 2009). Because of the locally labor-intensive nature of construction activities, the construction investment is believed to generate income directly to local residents and stimulate the local economy.

Although Cornell has long played a key role in the local economy, Cornell's tax-exempt status has resulted in animosity between the university and the city of

Ithaca. Tension simmers as local residents accuse Cornell of draining limited public resources without paying compensation. In addition, a lack of collaboration between the municipality and Cornell has raised questions about the contribution of Cornell to local communities. As one response to such concerns, the city of Ithaca and Cornell have proposed a revitalization plan of which the centerpiece is Cornell's role in the development of Collegetown, the university's nearest neighborhood.

In fact, Cornell has expressed its intention to contribute to local communities. The 2008 Cornell University comprehensive master plan states that "the plan will be driven by academic priorities and support the goals and aspirations of the university as it guides the campus's physical development over the next 10 to 25 years... While we have a remarkable campus, we want to make it better -- for our students, our faculty, our staff and our neighbors." This statement shows that Cornell is not only concerned with its academic community but also its local neighborhoods.

Both Ithaca downtown and Collegetown are considered as "opportunity areas" for greater Cornell presence (Cornell University, 2008). In fact, the university has already established its development at the Ithaca Commons in the downtown area. The addition of a sizeable workforce from Cornell to the downtown area has greatly benefited local businesses. As for Collegetown, its proximity and status as the urban edge of Cornell campus, the city and the university have a mutual interest to improve the Collegetown neighborhood.

The Collegetown Vision Statement, proposed by the Collegetown Vision Implementation Committee, aims to create new urban design guidelines in order "to create a diverse, commercially viable, mixed-use community." The motivation to engage actively in the local community is compelling since businesses in Collegetown have recently struggled economically (Collegetown Vision Implementation Committee, 2008). However, little attention has been paid to the economic impact of this revitalization plan. The concern is that only property owners may benefit disproportionately from such construction expenditures, which can lead to widening disparities.

2.1.1 Economic Impacts of Universities on Local Economies

Economic impacts of universities on their local communities have been a focus of many recent studies. In particular, various analytical methodologies have been employed to examine a university's impact on the local economy, since different analysis frameworks could lead to very different conclusions. According to Florax (1992), the economic effects of universities can be analyzed from three perspectives: through the university's input; through the university's output; or through a model that combines the input-output effects.

In addition, Drucker and Goldstien (2007) reviews four major approaches used to examine the impact of universities on regional economic development: (1) impact studies of individual universities, (2) surveys, (3) production-function estimation, and (4) cross-sectional and quasiexperimental designs. Even though the empirical results obtained from each method may vary in terms of the magnitude and levels of confidence, they all suggest substantial positive effects of universities on the regional economic development. Among these four approaches, impact studies of individual universities haven been widely conducted. For example, Carroll and Smith (2006) examine the economic impact of Bowling Green State University on Ohio State using the IMPLAN® (IMpact analysis for PLANning) economic impact modeling system, developed by MIG Inc. They find that the university returns an estimate of 8 dollars for every dollar received from state support in economic activities to the state economy.

Cornell University has studied its economic impact on New York State and published reports in 2007 and 2009. These studies were based on a Social Accounting Matrix (SAM) model capturing "multiplier effects" which include direct, indirect, and induced effects. However, SAM multipliers may not give realistic impacts because prices are treated exogenously, and excess production capacity is assumed in SAM. Moreover, there are no substitution parameters and feed-back effects in the SAM analysis. Thus, the economic impacts from SAM are likely to be overestimated and always positive.

A more realistic representation of the economy with price endogeneity, limited production capacity, substitution parameters, and feed-back effects can be studied in the framework of a Computable General Equilibrium (CGE) model. CGE models employ a SAM as a data system to capture interactions between agents in the economy due to changes in policy, technologies, or other external factors.

Most CGE models are used in analyses at the macroeconomic level to represent the economy of an entire country. These macro-level CGE models, however, may not be appropriate to analyze economic impacts in a smaller region because of the difference in economic structure. In particular, the assumption of constant-returns-to-scale (CRTS) in production technology in a standard CGE model may not be suitable for a small-area economy where the presence of imperfect competition may exist. Nonetheless, there have been a few attempts to address local economic impacts with this modeling methodology. For example, Holland, Stodick, and Devadoss (2004) develop a CGE model, which is adapted from the standard CGE model developed by Löfgren (2000), for regional economic analysis of Idaho and Washington states. In addition, Sue Wing and Anderson (2007) study the framework of CGE analysis on small-area economy in the US.

Using a CGE model to quantify the economic impact of Cornell's activities in the Collegetown Neighborhood, this study addresses two main questions. First, the paper examines whether university spending on local revitalization promotes a more egalitarian distribution of income. Second, it analyzes the implication of Cornell's eminent presence in Tompkins County's labor market on growth and income distribution. In addition to the standard CGE model, novel approaches for impact analysis of revitalization in a small urban area will be introduced. Particularly, the assumption of increasing-returns-to-scale (IRTS) in production technology is incorporated in the CGE model. Simulation results under alternative scenarios are presented, and policy implications are discussed in the end.

2.2 Literature review

2.2.1 Social Accounting Matrix (SAM)

A social accounting matrix has long been used to estimate economic impacts of many development plans and projects. A SAM model, which is based on an input-output analysis (I-O), can be used as both a data system and a conceptual framework (Azis and Mansury, 2003). The SAM analysis can capture inter-industry transactions of purchasing of final and intermediate goods and provide useful information as inter-sectoral linkage measures. It can also capture transfers among production sectors, factors of productions, and institutions such as households, firms, and the government in an economic system (Azis, Anantsuksomsri, and Tontisirin, 2008). A SAM analysis is useful for policy analysis since it is comprehensive and disaggregated, consistent in equal outlay, and complete in all identified buyer-seller transactions (Thorbecke, 1998).

The existence of excess capacity and unemployed or underemployed labor resources is an underlying assumption of SAM analysis. As long as excess capacity and abundant labor supply prevail, any exogenous shocks in demand can be satisfied through a corresponding increase in output without any effects on prices. Thus, prices are treated exogenously in a SAM analytical framework. In an economic development plan, SAM can be used as a tool to analyze the effects from the plan or exogenous shocks such as changes in demand of a certain production sector or government expenditure. A SAM multiplier, which captures direct, indirect, and induced effects, can be interpreted as the economy-wide impact from an increase in demand of a particular sector. Under the SAM framework, the effects are transmitted through the interdependent SAM system, namely direct, indirect, and induced effects, which are estimated through a multiplier process. From the standard SAM framework,

$$y_a = A_n y_n + x = (I - A_n)^{-1} x = M_a x$$

where x denotes exogenous demand,

y_n denotes endogenous total income,

A_n denotes average expenditure coefficients, and

M_a denotes accounting multiplier or SAM multiplier.

2.2.2 Structural Path Analysis (SPA)

The SAM multiplier analysis alone, however, cannot reveal the structural or behavioral mechanism responsible for the effects or paths that exogenous demand shocks pass through. Therefore, Structural Path Analysis (SPA) can be employed as an extension of the SAM multiplier analysis to identify various paths along which the exogenous shocks pass (Defourny and Thorbecke, 1984; Azis et al, 2008).

SPA decomposes the SAM multiplier and identifies a network of paths through which the “effect” is transmitted in the economic system. In order to understand how

SPA works, consider an effect travelling from an origin pole i to a destination pole j. Under the SAM framework, this effect can be considered as an average expenditure propensity "a_{ji}" or marginal expenditure propensity "c_{ji}". The link between pole i and j is denoted by "$\mathrm{arc}(i, j)$". Let "path" denotes a sequence of consecutive arc; "$\mathrm{elementary\ path}$" denotes a path that does not pass the same pole more than once; "$\mathrm{circuit}$" denotes a path, which the origin pole is the same as the destination.

SPA breaks down influence into three types of effects: 1) direct effect (DE), 2) total effect (TE), and 3) global effect (GE). Direct effect $DE_{(i\to j)}$ can be measured as average expenditure propensity a_{ji} that passes through an elementary path from i to j.

$DE_{(i\to j)} = a_{ji}$

The direct effect $DE_{(i\to j)}$ can also travel to multiple poles along the $\mathrm{path}(i, \ldots, j)$. If it is the case, the magnitude of the direct effect is the product of average expenditure propensity of arcs connecting the path. As shown in Figure 2.1, the direct effect that passes through $\mathrm{path}(i, x, y, j)$ equals $a_{xi} \cdot a_{yx} \cdot a_{jy}$. As shown in Figure 2, the total effect $TE_{(i\to j)}$ captures all direct effects that pass from pole i to pole j.

The global effect $GE_{(i\to j)}$ measures the total effects on income or output of pole j as a consequence of a shock from pole i. Unlike the direct effect, the global effect captures all direct, indirect, and induced resulting from circuits along $\mathrm{path}(i, \ldots, j)$ and can be computed by summing all $TE_{(i\to j)}$ (see Figure 2.3). Practically by construction, the global effect is an element in SAM multiplier M_a.

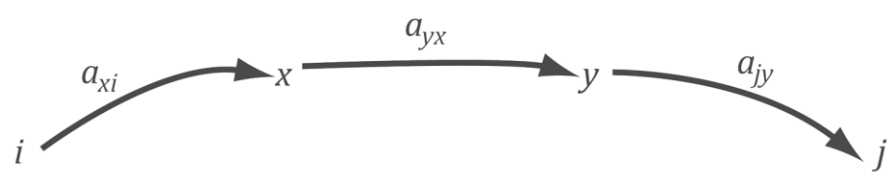

Figure 2.1: A Direct Effect $DE_{(i \rightarrow j)}$ in the Structural Path Analysis

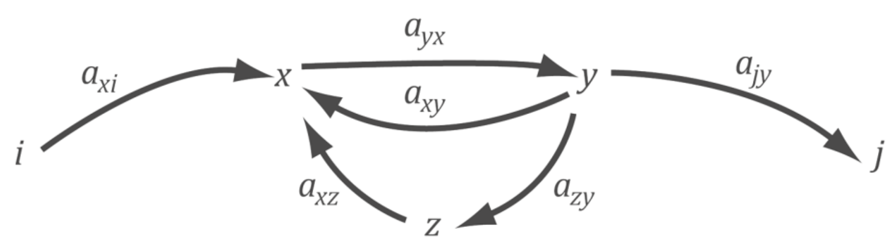

Figure 2.2: A Total Effect $TE_{(i \rightarrow j)}$ in the Structural Path Analysis

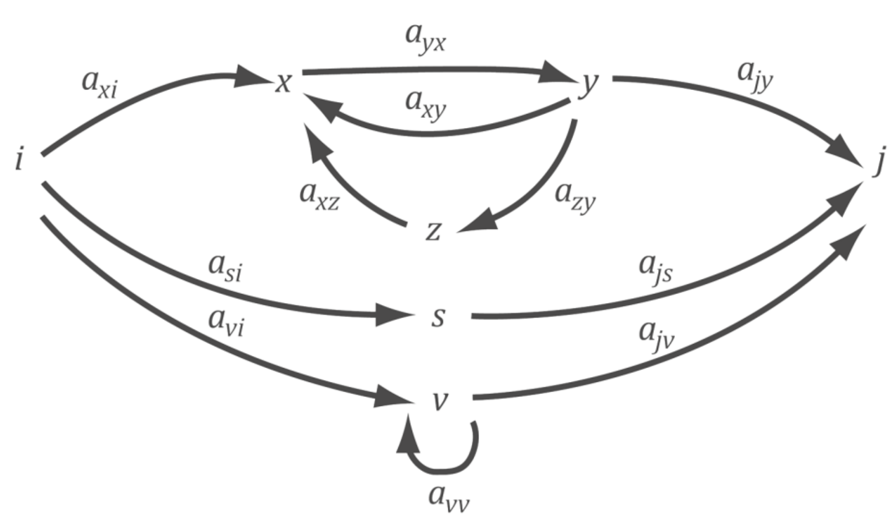

Figure 2.3: A Global Effect $GE_{(i \rightarrow j)}$ in the Structural Path Analysis

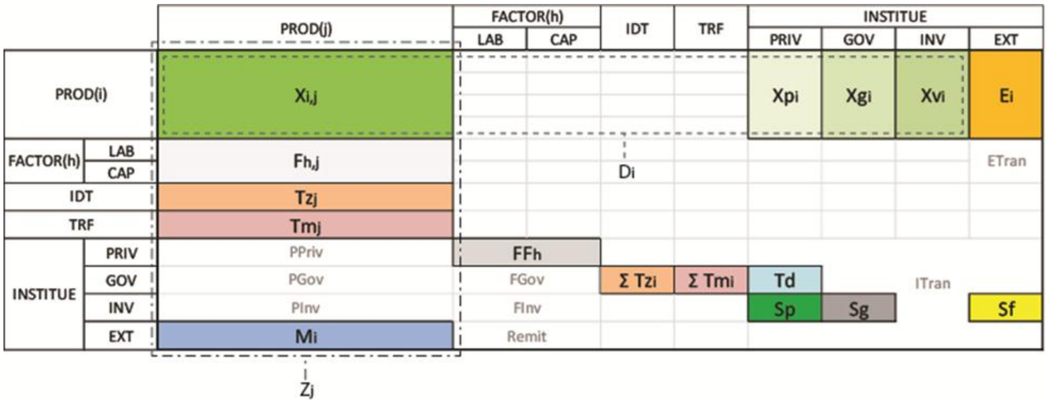

Figure 2.4: Structure of Tompkins 2009 SAM and its variables

2.2.3 Computable General Equilibrium (CGE)

The Computeable General Equilibrium is sometimes known as the Applied General Equilibrium (AGE), initially developed by Scarf (1967) and Scarf and Hansen (1973). A CGE model is based on the general equilibrium theory of the competitive market economy. In the model, a representative household determines its consumption bundles to maximize its utility subject to a budget constraint while a firm maximizes its profits by managing its inputs and outputs subject to its production technology. The model involves optimizing behaviors of economic agents under given resource and technology constraints, and under indicators from market prices. The CGE framework is usually based on a Social Accounting Matrix (SAM). The structure of a SAM of Tompkins County is shown in Figure 2.4.

The structure of the CGE model in this study is based on the standard CGE model developed by Hosoe, Gasawa, and Hashimoto (2010) and is illustrated in Figure 2.5. The nested structure represents the connection between production and good markets. The overview of the interrelation of goods and production factors in the model can be explained as following (from the bottom to the top):

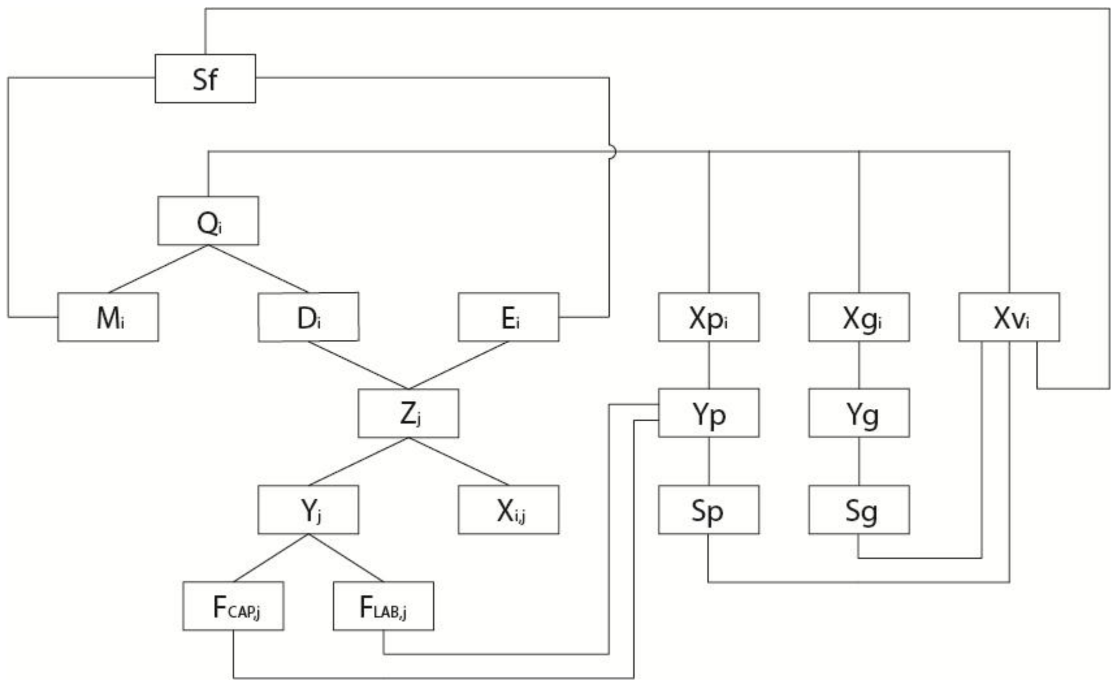

Figure 2.5: The structure of standard CGE model

1. The intermediate goods (Xi,j) and the value-added of production or composite factor (Yj), which consists of Labor (FLAB,j), and capital (FCAP,j), are used to produce the output (Zj).

2. Some outputs (Zj) are exported (Ei) and the rest are sold domestically (Di). The proportion of exported and domestic goods is controlled by the function of Constant Elasticity of Transformation (CET).

3. The domestic goods (Di) and imported goods (Mi) are used to produce composite goods (Qi) to serve domestic demands. The proportion of imported and domestic goods is controlled by the function of Constant Elasticity of Substitution (CES).

4. The composite goods (Qi) will be distributed among private consumption (Xp), government consumption (Xg), investment (Xv), and intermediate uses by production sectors based on the Cobb-Douglas utility function.

5. Utility subject to a budget constraint (UU) is derived by maximizing private consumption.

The income of private institutions (Yp) consists of factors of production (FF) and institutional transfers. Government revenues (Yg) are from direct taxes (Td), production taxes (Tz), import tariff (Tm), and institutional transfers. In the case of Tompkins County, import activities within New York State and the rest of the US have no import tariff. Based on the marginal propensity to consume, the revenues of each institution will be allocated to savings and consumptions. The net export is denoted as a foreign saving (Sf). Again, in the case of Tompkins County, foreign sectors include the rest of the US and the rest of the world. The total savings consist of private saving (Sp), government saving (Sg), and foreign saving (Sf). The consumption and investment behaviors of private institutions (Xp) and government (Xg), based on the Cobb-Douglas utility function, are determined by prices of goods and disposable incomes. In this economy, the assumption about the balance of total saving and total investment must hold.

2.3 Data

In this study, the 2009 Social Accounting Matrix (SAM) of Tompkins County, New York is used as the major database for Structural Path Analysis (SPA) and Computable General Equilibrium (CGE) analysis. The SAM used in this study is produced by IMPLAN. The original SAM consists of 533 accounts of which 520 accounts are endogenous. Out of these endogenous accounts, 508 accounts are of production sectors; two accounts are of factors of production (i.e., capital and labor); ten private institutions consist of nine households groups by income levels and firm. State and federal governments and the rest of US and the rest of the world are exogenous accounts.

The production sectors in the original SAM of Tompkins County are aggregated into 24 major production sectors based on the 2007 North American Industry Classification System (NAICS) using IMPLAN software. In this SAM, Cornell University is recorded as a part of production sector number 392 (Junior colleges, colleges, universities, and professional schools), not as an institution. In Tompkins County, there are three major higher education institutes: Cornell University, Ithaca College, and Tompkins Cortland Community College. In order to analyze the role of Cornell University, sector 392 of Tompkins County is disaggregated into two sectors: Cornell University and other universities. The disaggregation is based on the financial data of Cornell: financial statement, data on purchase and procurement, payroll, and construction of Cornell University in 2007-2008 fiscal year.

The aggregation procedure is processed in Microsoft Excel software. After exporting the aggregated SAM of 2009 Tompkins County into an excel file format from IMPLAN software, 24-sector SAM are aggregated into 16 major production sectors, nine household groups are categorized into three income groups, and all state and federal government sectors are grouped into one government sector. Like the aggregation procedure, the disaggregation procedure of Cornell University sector from the university sector is managed in Microsoft Excel. The following steps constitute the disaggregation procedure:

- Categorize payment and receive items of Cornell's financial data according to the sectors of Tompkins County's SAM,
- Proportionally disaggregate all sectors in the column of university sector in the SAM based on the payments of Cornell and all sectors in the row of university sector based on the receives, respectively, and

- Balance corresponding cells of the Cornell sector and university sector to equate the sums of each row and column.

After aggregation and disaggregation procedures, the final SAM consists of 17 production sectors in the model (see Appendix 2.1) including Cornell University as a production sector, two types factors of production (labor and capital), three types of taxes (income tax, indirect tax, and tariff), saving-investment, and six institutes (three household groups, firm, government, and the rest of the world). The SAM used in this study is shown in Appendix 2.2.

In this study, the solution of the CGE model is computed in the General Algebraic Modeling System (GAMS) developed by GAMS Development Corporation, Washington, DC, USA. The following are key properties of this CGE model:

- Cornell University is one of the production sectors.
- Labor and capital is assumed to be fully employed.
- Wage is set endogenously.

2.4 Methodology

In order to calculate a quantitative result of economic impact analysis, most of studies are usually employed under the framework of SAM, and IMPLAN is widely-known software used in the economic impact study. Many planners, however, argue that the simulation using IMPLAN is sometimes a "black box" approach since the underlining computational methodology is not explicit. In this study, computation of SAM multipliers and simulation are done in Microsoft Excel rather than in IMPLAN. Thus, all transmission mechanisms in the analysis can be traced. The SAM multiplier analysis of 2009 SAM is used to quantify economic impacts of Cornell University in Tompkins County, in particular the key roles of the university as employers. In addition to the SAM multiplier analysis, the Structural Path Analysis (SPA) is also employed to identify the origin and destination poles that the impacts from Cornell pass through.

The 2009 Tompkins County SAM is then used as the database to calibrate the small-area CGE model. The simulation model, based on the proposal of the Collegetown development plan, provides a quantitative result of economic impact to the local economy. The result will reveal, vis-à-vis the concern of this development plan, whether revitalization expenditure will benefit all members of the community or mainly property owners disproportionately. In addition, in order to analyze the implied effect of Cornell's eminent presence in Tompkins County's labor market on growth and income distribution, the assumption of increasing-returns-to-scale (IRTS) in production technology is incorporated in the CGE model extension based on the model developed by Hosoe *et al* (2010).

In this study, the specification to incorporate the scale economies in production is fixed costs. The assumption of IRTS in this model is that Cornell University has fixed costs and variable costs to operate its production. These payments ($\mathrm{FC_j}$), which may be in the form of payrolls, are paid by Cornell to private institutes, i.e., households. So the functions of private saving (Sp), household demand for goods ($\mathrm{Xp_i}$), and government tax revenue (Td) are modified based on the share of fixed costs (ν_i) in the total capital service payment ($\mathrm{SAM_{Capital,j}}$) of Cornell. The detail of additional and modified parameters, variables, and equations is shown in Appendix 2.3.

2.5 Results

Using the methodology discussed above, the evidence of the university's role in the local economy is shown in the following order: SAM multiplier analysis, SPA, and CGE. The results of SAM analysis will show the socioeconomic impact of Cornell University's investment on real estate projects. In addition to the SAM multiplier analysis, the SPA will reveal paths of the impact and bottlenecks that may need a policy intervention. The results of the CGE model analysis will further illustrate a more realistic impact of the investment with feedback effects. Finally, the policy implications will be discussed.

2.5.1 Simulation using the framework of Social Accounting Matrix (SAM)

According to the proposal of the Collegetown Vision Statement, the exogenous shocks on the real estate and retail sectors are injected to the local economy to create a mixed-use community. In the simulation scenario, the 1% increases in the investment of each sector are assumed to be invested in real estate and retail development. The total additional economic impact from the $0.46 million investment in College town is estimated to be $2.05 million. Cornell, government, and rest-of-the-world sectors are treated exogenously. The details of the simulation are shown in Appendix 2.4.

The results from the simulation show that university spending on revitalization activities is more economically beneficial to medium- and high-income households than to low-income household. As a result of this additional investment in the real estate and retail sectors, the incomes of low-, medium-, and high-income households increase by 0.0066%, 0.0078%, and 0.0063%, respectively, suggesting that the economic impact of the revitalization plan benefit equiproportionally local residents in all income groups. This result supports the proposal of the Collegetown Vision Statement to create a commercially viable and mixed-use community as suggested in the development plan. The SAM analysis can now answer one of the two main questions of this study. Cornell spending on revitalization activities is economically beneficial to all households.

This simulation of the exogenous shocks, however, may not represent reality in the economy, as mentioned earlier, because of limitations of SAM analysis in which prices are treated exogenously and excess production capacity is assumed. In order to generate more realistic results, the simulation of exogenous shocks using a CGE model based on the database of 2009 Tompkins County SAM is needed.

2.5.2 Structural Path Analysis (SPA)

The result from the SPA simulation of Cornell's investment on mixed-used development using 2009 SAM of Tompkins County is based on the SAM multiplier analysis discussed earlier. Table 2.1 shows that the production sectors that affect all households in the local economy are 'other sector', retail, professional services, others universities sector, and accommodation sector, which are ranked among the top five production sectors for all household groups. The global effects suggest that the retail sector generates higher economic transaction to high and medium income households than to low income household. For example, for every one dollar increase in the output from retail sector, it will generate $0.041 increase in income of the low-income household, while contributing $0.27 and $0.304 to the medium- and high-income groups, respectively. Like the retail sector, the global effects of the real estate sector suggest that the retail sector generates higher economic transaction to high- and medium-income households than to the low-income household. The global effects of the real estate sector on low-, medium-, and high-income household are 0.037, 0.199, and 0.277, respectively.

Table 2.1: The SPA global effect of production sectors to household groups

Origin (Industry)	Destination (Household)	Global Effect
Other sector	Low-income	0.042
Retail	Low-income	0.041
Professional services	Low-income	0.410
Other universities	Low-income	0.039
Accommodation	Low-income	0.039
Other sector	Medium-income	0.282
Other universities	Medium-income	0.272
Retail	Medium-income	0.270
Professional services	Medium-income	0.266
Accommodation	Medium-income	0.263
Other sector	High-income	0.308
Retail	High-income	0.304
Professional services	High-income	0.301
Other universities	High-income	0.292
Accommodation	High-income	0.291

The SPA results of the impact from Cornell's investment in the retail sector on three household groups, shown in Figure 2.6, illustrate that professional services and others sectors also play an important role in the economic impact of the investment in the retail sector on all households. The orders of paths are ranked according to the global effects. The SPA result suggests that the economic impacts from the retail sector to all households via employment (Labor) are high.

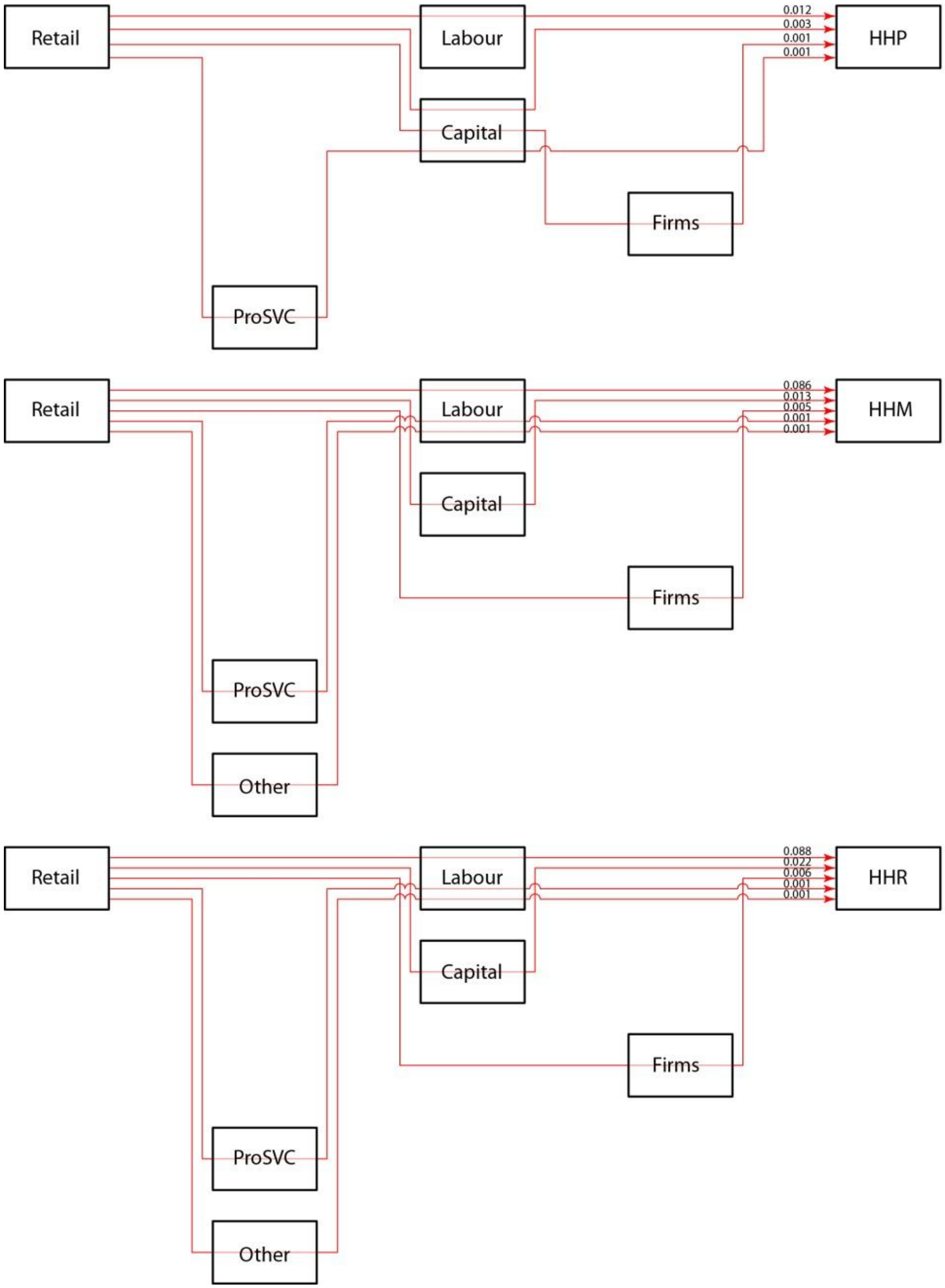

Figure 2.6: **The paths from the investment on retail sector to households**

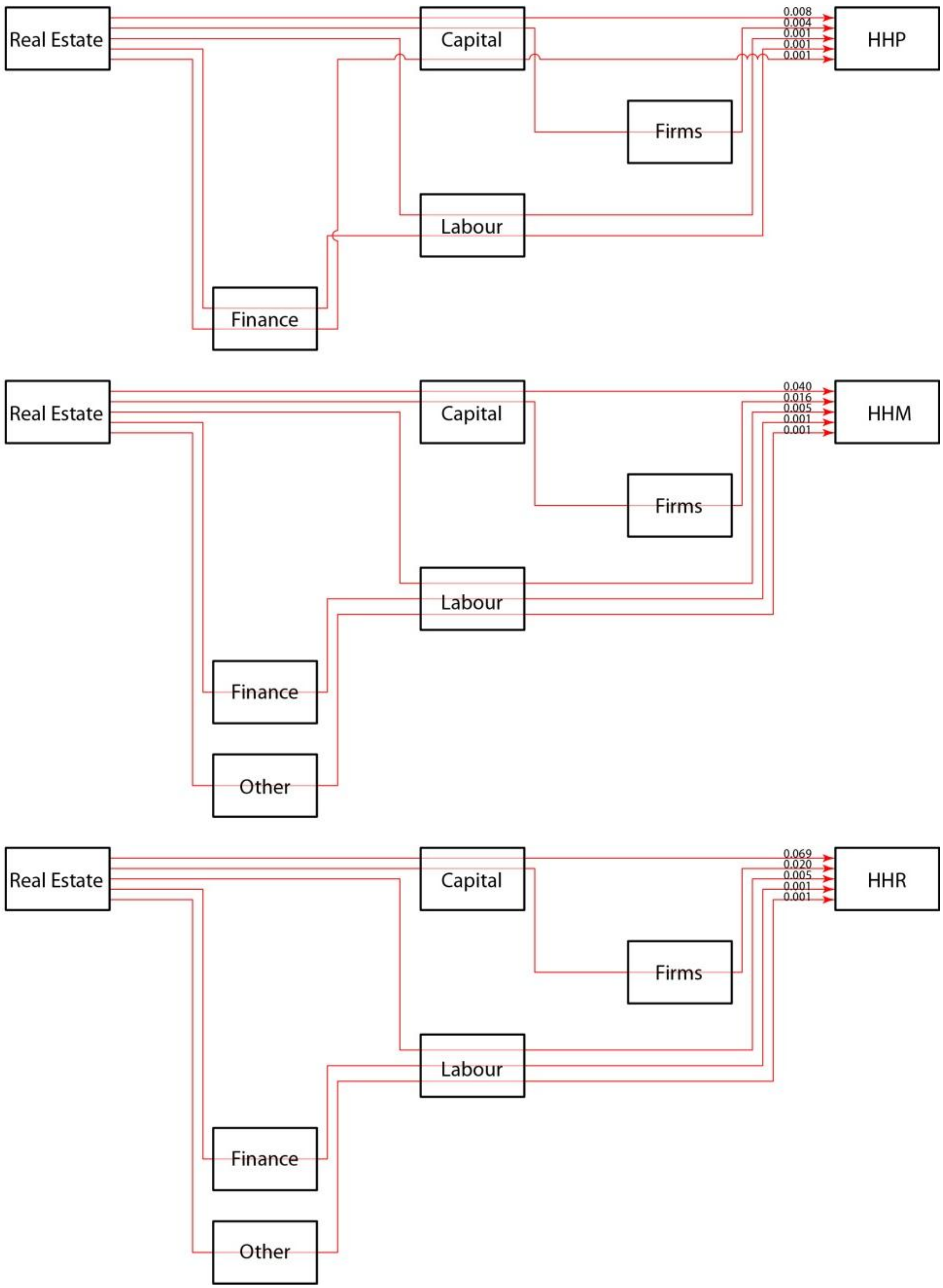

Figure 2.7: The paths from the investment on real estate sector to households

Figure 2.7 shows the SPA results of the impact from the investment in the real estate sector on the three household groups. It demonstrates that the financial and ‘others sector’ also play an important role in the economic impact on the retail sector. The SPA result suggests that the economic impacts from the real estate sector to all households via capital are much higher than via employment. The results suggest the possible bottle necks to the transmission of economic impact to households, especially low-income households, are in the labor sector.

However, the results of the SPA can illustrate only structures and behavioral mechanisms of the economic impact. It can not provide quantitatively the impact from the exogenous shock according to the development plan. Thus, in the following section the economic impact of Cornell is analyzed using a CGE model.

2.5.3 Simulation using the framework of Computable General Equilibrium (CGE)

The CGE model is based on the structure of standard CGE model developed by Hosoe *et al* (2010). In order to generate comparable results from the CGE simulation to those of the SAM multiplier analysis, the 1% increase each in retail and real estate sectors is invested from Cornell. As mentioned earlier, the university sector is categorized in SAM as one of the production sectors, not an institution. The exogenous shocks, therefore, are applied to the production sectors. The objective of the simulation is to maximize utility derived from private consumption, which is represented by the utility function shown in the Appendix. The results of the standard CGE model—with an assumption of constant-returns-to-scale production—are shown in Table 2.2.

Table 2.2: Simulation results from the standard CGE model

Economic Indicators	Base case	Investment	% Change
Utility	496756.413	497,442	0.14%
Total labor income	2843.918	2,850.281	0.22%
Total income-Poor HH	285.029	285.199	0.06%
Total income-Medium HH	729.297	729.669	0.05%
Total income-Rich HH	721.194	721.391	0.03%
Average price of composite goods	1.000	0.999	-0.05%
Tax revenue	220.031	219.798	-0.11%

In this simulation scenario, the result shows that the investment from Cornell would provide positive benefits to the local community as the utility level increases by 0.138%, from 496,756 to 497,442 units. The result also shows that total labor income ($\sum_j F_{LAB,j}$) increases by 0.22% from 2,843.918 to 2,850.28, suggesting that the revitalization plan will somewhat benefit the employment of local residents. In the SAM of Tompkins County shown in the Appendix, the amount of household saving is zero, indicating that households have no saving, and households spend all their disposable incomes on consumptions. Thus, household consumptions could be an indicator of household purchasing power. The total consumptions of low-, medium-, and high-income households ($\sum_i Xp_{i,hh}$) increase by 0.06%, 0.05%, and 0.02%, respectively, which contributes to higher overall utility as discussed previously. The effect of the investment is found to be unevenly distributed, and the low- and medium-income households receive more benefit than the high-income household. The investments from Cornell also put a downward pressure on the overall prices. As can be seen, the average price of composite goods ($\sum_i pq_i$) decreases by 0.05%. In addition, the government received less total production tax ($\sum_i Td_i$) by 0.11%.

Since Cornell University is a major employer and purchaser in Tompkins County, the next analysis undertaken assumes the behavior of Cornell is represented by an increasing-returns-to-scale production function. Thus, in this modified CGE model, the share of fixed costs in capital costs (ν_i) of Cornell is introduced and assigned to 0.01, while the share of the other sectors is assigned to 0. With the same amount of exogenous shock, the results of economic indicators are shown in Table 2.3. Unlike the previous results, when Cornell's production function is assumed to be constant-return-to-scale, the utility level decreases by 0.53%, from 496,756 to 494,086 units. This is because the total consumptions of low-, medium-, and high-income households ($\sum_i Xp_{i,hh}$) decreases by 0.3126%, 0.1588%, and 0.0671%, respectively.

The impact is distributed unevenly, and the low-income group seems to be the hardest hit. The investment of Cornell also puts an upward pressure on the price of composite goods. The average price of composite goods ($\sum_i pd_i$) increases by 0.56%. The total labor income ($\sum_j F_{LAB,j}$) increases by 0.22% from 2,843.918 to 2,850.281, suggesting that the plan will benefit the local labor market. The government also benefits from the investment as it receives more total production tax ($\sum_i Td_i$) by 0.56%.

Table 2.3: Simulation results from the modified CGE model with IRTS

Economic Indicators	Base case	Investment	% Change
Utility	496,756.413	494,086.708	-0.54%
Total labor income	2,843.918	2,850.281	0.22%
Total income-Poor HH	285.029	284.138	-0.31%
Total income-Medium HH	729.297	728.139	-0.16%
Total income-Rich HH	721.194	720.710	-0.07%
Average price of composite goods	1.000	1.006	0.56%
Tax revenue	220.031	221.264	0.56%

2.5.4 Policy Implication

The SAM, SPA, and CGE analyses of the economic impact of Cornell University's investment in mixed-use development projects show that the impact would not always be positive and evenly distributed to the local community. The impacts of Cornell's investment to some degree vary, depending on assumptions about the structure of local economy employed in different analytical methods. The SAM multiplier analysis suggests only positive effects from the investment. The CGE models, on the other hand, suggest both positive and negative impacts. With CTRS assumption in the CGE simulation, the economic impacts are found to be positive, and the medium- and high-income groups seem to enjoy the benefit more than the low-income group. Since Cornell is a major employer and purchaser in Tompkins County, results from the CGE simulation with the IRTS assumption would seem to be more realistic. The results from the CGE simulation with the IRTS assumption show that the investment would benefit the local labor market. However, the benefits may be offset by the increase in an average commodity price, resulting in lower household consumption and overall utility level. This hike in the price would heighten tensions between Cornell and local communities. The impact hits low-income households the hardest in terms of total household consumption. The SPA results suggest that this is because of the presence of a bottleneck in the transmission mechanism to low-income households in the labor sector. Thus, to reduce tensions between the university and local communities, more attention should be paid to the labor market, particularly of the low-income group. This outreach to the local labor market would improve town-and-gown relations between Cornell and its local communities. As an economic engine in Tompkins County and New York State, Cornell can enhance its role in the pursuit of equality by further investing in local communities.

2.6 Conclusion

The quantitative analyses of the university-led revitalization plan, using SPA, SAM analysis, and CGE models confirm that Cornell University indeed plays an important role in Tompkins County, New York. The SPA has illustrated the paths of economic impact from university economic activities that pass through other production sectors and factors of production to households in the local economy. The SAM analysis shows that the investment in mixed-use development in Ithaca Collegetown will benefit all local residents. However, it might widen disparity in the community due to disproportional income distribution. While the study using CGE modeling suggests that the Cornell investment in Collegetown stimulates “a diverse, commercially viable, mixed-use community,” the investment may not benefit all residents in the local community equally. The result from the CGE simulation with CRTS shows that the distribution of the impact is likely to benefit the medium- and high-income households more than the low-income households. On the other hand, the result from CGE simulation with IRTS suggests that the benefit to labor incomes may be offset by the increase in commodity prices. As a leader in education and economic activities in local communities and New York State, Cornell should pay more attention to its investment as its impact may not be equally distributed to the local residents. Cornell’s contributions to the lives and livelihood of its students, faculty members, staffs, and local residents certainly play an important role in its success globally, proving that big success can start in small places.

APPENDIX 2.1

Description of 17 production sectors in 2009 Tompkins SAM using in the model

AGR	Agricultural sector
MIN	Mining sector
UTL	Utilities sector
CON	Construction sector
MFG	Manufacturing sector
WSALE	Wholesale sector
RETAIL	Retail sector
TRANS	Transportation sector
INFO	Information sector
FIN	Financial sector
RE	Real estate sector
PROSVC	Professional sector
CORNELL	Cornell University
UNIV	Other universities sector
ACCOM	Accommodation sector
FOOD	Food service sector
OTH	Others sector

APPENDIX 2.2

The SAM of 2009 Tompkins County

Sectors	AGR	MIN	UTL	CON	MFG	WSALE	RETAIL
AGR	16.77287	0.050457	0.000141	0.079395	7.063268	0.000782	0.077965
MIN	0.01219	11.26765	2.037016	0.111735	5.561095	0.000415	0.000589
UTL	0.864422	1.636412	159.1691	0.622139	16.09445	0.36773	1.26057
CON	0.104412	0.910899	1.149838	174.8695	1.638935	0.05282	0.196442
MFG	0.471963	0.473813	0.184214	1.711346	64.44189	0.131351	0.142274
WSALE	0.649449	0.569684	0.22556	1.788524	17.62683	74.01084	0.53579
RETAIL	0.03443	0.144467	0.020276	5.173808	1.914904	0.073549	240.8286
TRANS	0.530492	0.747576	2.761477	1.127313	9.622649	1.226939	1.582307
INFO	0.021999	0.096946	0.161095	0.569028	3.007821	0.26971	0.516838
FIN	0.677892	0.64404	1.167593	0.784763	2.191723	0.863679	1.819696
RE	1.698872	0.260371	0.372353	0.545998	2.182666	0.763497	3.326767
PROSVC	0.359063	3.904414	3.824587	11.41977	24.59816	3.491098	5.090456
CORNELL	0.144364	0.000124	0.129311	0.006288	0.014672	0.047356	0.203708
UNIV	0.111221	9.53E-05	0.016484	0.003127	0.007296	3.33E-07	0.1013
ACCOM	1.89E-06	2.77E-05	0.000138	9.12E-05	0.000542	4.8E-05	2.65E-05
FOOD	0.024529	0.073408	1.102571	0.280609	2.046578	0.237816	0.447967
OTH	0.216179	2.223563	36.46853	2.530947	16.63837	2.339883	3.175744
LAB	24.11723	15.63933	36.2442	56.29709	231.806	29.7254	137.4371
CAP	6.269607	41.07222	65.99634	22.88158	93.66258	11.43247	45.86458
IDT	0.955347	3.252364	21.65613	1.092841	11.64108	11.24233	47.94167
TRF	0	0	0	0	0	0	0
HHP	0	0	0	0	0	0	0
HHM	0	0	0	0	0	0	0
HHR	0	0	0	0	0	0	0
GOV	0.100702	0	0.161413	0	0	0	0
FIRM	0	0	0	0	0	0	0
INV	0.000424	0.000111	0	0	2.502494	0	0
EXT	31.13157	44.9867	37.99264	72.43665	636.203	17.41775	24.46023

The SAM of 2009 Tompkins County (Continued)

Sectors	TRANS	INFO	FIN	RE	PROSVC	CORNELL	UNIV
AGR	0.000175	4.93E-05	1.98E-05	0.069221	0.035571	0.22293	0.152465
MIN	0.005735	0.005323	5.48E-05	0.020193	0.013641	0.000128	8.77E-05
UTL	0.267108	0.42133	0.29305	2.809097	1.259483	59.23833	40.51384
CON	0.273663	0.314071	0.571988	7.216581	0.634558	0.003262	0.002231
MFG	0.451672	0.288909	0.086915	0.284037	4.042378	2.32285	1.588627
WSALE	0.302012	0.398822	0.127442	0.340825	0.59964	4.041477	2.764017
RETAIL	0.201047	0.023659	0.118027	1.354632	0.135796	0.058972	0.040332
TRANS	57.04419	0.724311	0.560057	0.340199	2.070171	2.983802	2.04066
INFO	0.197584	76.2302	1.279813	0.322817	21.27134	8.64949	5.915496
FIN	1.297844	0.875369	237.0682	29.6829	4.729981	1.50178	1.027087
RE	0.593348	1.27354	2.167507	551.4986	6.799602	45.98132	31.44721
PROSVC	1.318485	8.406829	10.23088	6.94289	318.8705	27.38789	18.73093
CORNELL	0.007256	0.070448	0	1.34E-05	0.041282	41.76418	28.56305
UNIV	0.003483	0.002381	0	2.59E-05	0.003859	0.012786	0.008744
ACCOM	3.16E-05	0.000281	0.000592	2.744966	0.001273	0.001558	0.001065
FOOD	0.355119	0.638116	2.331358	0.667217	4.772582	5.821309	3.981267
OTH	7.280183	4.480294	5.502249	12.88757	10.11517	22.90262	15.6634
LAB	26.70032	30.37875	68.23823	17.13632	164.0171	636.1106	435.0441
CAP	12.66166	32.21723	65.59613	296.6192	51.4341	14.71925	10.06668
IDT	2.907963	4.271737	5.281504	63.00681	6.314043	10.37269	7.094017
TRF	0	0	0	0	0	0	0
HHP	0	0	0	0	0	0	0
HHM	0	0	0	0	0	0	0
HHR	0	0	0	0	0	0	0
GOV	0	0.140086	0	0	0.11319	0.301976	0.206525
FIRM	0	0	0	0	0	0	0
INV	6.78E-06	0.000183	0	0	0	0	0
EXT	26.36818	42.98003	58.5378	90.56815	75.72412	249.2291	170.451

The SAM of 2009 Tompkins County (Continued)

Sectors	ACCOM	FOOD	OTH	LAB	CAP	IDT	TRF
AGR	0.025598	0.392298	0.345558	0	0	0	0
MIN	0.006935	0.004835	0.889084	0	0	0	0
UTL	4.604606	4.091451	10.97384	0	0	0	0
CON	0.826749	0.369455	5.841894	0	0	0	0
MFG	0.268584	1.453607	4.080204	0	0	0	0
WSALE	0.334867	2.672343	5.45949	0	0	0	0
RETAIL	0.038867	0.80681	1.905277	0	0	0	0
TRANS	0.511645	1.123327	5.659552	0	0	0	0
INFO	1.009854	1.179567	6.177132	0	0	0	0
FIN	1.503825	2.321496	25.82271	0	0	0	0
RE	1.682359	5.807528	27.70837	0	0	0	0
PROSVC	9.140907	7.732035	41.91933	0	0	0	0
CORNELL	0	0	0.072103	0	0	0	0
UNIV	0	0	0.049312	0	0	0	0
ACCOM	0.081537	0.000282	0.001026	0	0	0	0
FOOD	3.034946	177.92	6.990554	0	0	0	0
OTH	7.109566	7.523762	1119.126	0	0	0	0
LAB	71.90447	115.9787	753.5073	0	0	0	0
CAP	13.89527	31.66986	131.9724	0	0	0	0
IDT	4.653313	17.31321	1.033785	0	0	0	0
TRF	0	0	0	0	0	0	0
HHP	0	0	2.357556	125.2274	31.40076	0	0
HHM	0	0	10.95988	923.1969	157.2794	0	0
HHR	0	0	8.220007	934.7146	267.0941	0	0
GOV	8.07E-05	0	33.81874	341.5899	7.908013	220.0308	0
FIRM	0	0	0	1.831327	221.6481	0	0
INV	0	0	14.02166	0	377.1231	0	0
EXT	35.10574	85.24179	298.4957	523.722	0	0	0

The SAM of 2009 Tompkins County (Continued)

Sectors	HHP	HHM	HHR	GOV	FIRM	INV	EXT
AGR	0.6235	1.572777	1.250029	0.053481	0	1.26E-05	56.48067
MIN	0.000771	0.00214	0.00167	0.011091	0	0.004563	107.9977
UTL	10.11662	22.41344	15.65406	1.592106	0	0	16.57782
CON	0.00001	0.00001	0.00001	48.12212	0	106.508	4.725101
MFG	3.141507	7.803974	6.494776	1.245396	0	6.751843	1042.605
WSALE	2.575348	14.91256	12.889	1.448573	0	1.770039	7.652336
RETAIL	30.71987	82.81991	107.5118	0.008297	0	7.524111	33.55318
TRANS	3.901718	8.386318	8.622623	1.397082	0	0.340667	24.93199
INFO	3.974478	9.874855	9.005026	2.301605	0	4.462081	47.64718
FIN	12.62856	45.37024	48.16837	1.179958	0	0	36.66411
RE	59.01835	159.6944	180.0112	1.450925	0	0	0.227472
PROSVC	4.598727	14.27532	11.67886	14.6379	0	65.65742	58.7829
CORNELL	13.22064	12.84174	14.41564	0.985974	0	0	1049.772
UNIV	9.041767	8.782631	9.859038	0.67432	0	0	717.9527
ACCOM	0.015476	0.02576	0.032673	0.000304	0	0	152.832
FOOD	20.57175	59.36719	59.84215	2.32154	0	0	110.7738
OTH	110.8786	281.1543	235.7557	385.1051	0	0.673487	227.6572
LAB	0	0	0	0	0	0	0
CAP	0	0	0	0	0	0	114.4224
IDT	0	0	0	0	0	0	0
TRF	0	0	0	0	0	0	0
HHP	0.402473	1.167817	3.964649	233.7875	18.64766	93.13975	1.704161
HHM	1.743481	5.058808	17.17426	256.9322	82.2215	8.902362	7.922361
HHR	2.265505	6.573484	22.31648	98.84552	100.7343	92.57186	5.94184
GOV	0.674234	154.9559	272.1055	1005.804	90.90714	638.0032	19.56279
FIRM	0	0	0	16.62547	0	52.40572	0
INV	0	0	0	626.5541	0	50.19245	300.7243
EXT	221.6864	574.3376	502.5242	85.29973	0	242.2112	0

APPENDIX 2.3

Description of sets in the CGE model

i or j	Production sectors
h	Factors of production (labor and capital)

Description of parameters in the CGE model

FF_h	Factor endowment of the h^{th} factor
ν_i	Share of fixed costs in capital costs (in the CGE model with IRTS)
pWe_i	Export price in US dollars
pWm_i	Import price in US dollars
τz_i	Production tax rate
τm_i	Import tariff rate
σ_i	Elasticity of substitution
φ_i	Elasticity of transformation
η_i	Substitution elasticity parameter
φ_i	Transformation elasticity parameter
α_i	Share parameter in utility function
$\beta_{h,j}$	Share parameter in production function
b_j	Scale parameter in production function
$ax_{i,j}$	Intermediate input requirement coefficient
ay_j	Composite factor input requirement coefficient
μ_i	Government consumption share
λ_i	Investment demand share
δm_i	Share parameter in Armington function
δd_i	Share parameter in Armington function

Description of parameters in the CGE model (continued)

γ_i	Scale parameter in Armington function
ξd_i	Share parameter in transformation function
ξe_i	Share parameter in transformation function
θ_i	Scale parameter in transformation function
ssp	Average propensity for private saving
ssg	Average propensity for government saving
taud	Direct tax rate

Description of variables in the CGE model

Y_j	Composite factor
$F_{h,j}$	The h^{th} factor input by the j^{th} firm
FC_j	The fixed costs in j^{th} firm (in the CGE model with IRTS)
$X_{i,j}$	Intermediate input
Z_j	Output of the j^{th} good
Xp_i	Household consumption of the i^{th} good
Xg_i	Government consumption
Xv_i	Investment demand
E_i	Exports
M_i	Imports
Q_i	Armington's composite good
D_i	Domestic good
Sp	Private saving
Sg	Government saving
Sf	Foreign saving in US dollars
Td	Direct tax

Description of variables in the CGE model (continued)

Tz_j	Production tax
Tm_i	Import tariff
UU	Utility (fictitious)

Equations in the CGE Model

The following system of equations is used in the CGE model in this study:

Domestic production:

1. The composite factor aggregating function

$$Y_j = b_j \cdot \prod_h (F_{h,j}{}^{\beta_{h,j}})$$

2. The factor demand function

$$F_{h,j} = \frac{\beta_{h,j} \cdot py_j \cdot Y_j}{pf_h}$$

In the model with increasing-returns-to-scale, the additional variable of the fixed costs in the j^{th} firm is incorporated into the model.

$$FC_j = \upsilon_j \cdot SAM_{Capital,j}$$

3. The intermediate demand function

$$X_{i,j} = ax_{i,j} \cdot Z_j$$

4. The composite factor demand function

$$Y_j = ay_j \cdot Z_j$$

5. The unit cost function

$$pz_j = (ay_j \cdot py_j) + \sum_i (ax_{i,j} \cdot pq_i)$$

In the model with increasing-returns-to-scale, the original unit cost function is modified as follows:

$$pz_j = \left(ay_j \cdot py_j\right) + \sum_i \left(ax_{i,j} \cdot pq_i\right) + \frac{FC_j}{Z_j}$$

Government Behavior:

6. The direct tax revenue function

$$Td = taud \cdot \sum_h (pf_h \cdot FF_h)$$

In the model with increasing-returns-to-scale, the original unit cost function is modified as follows:

$$Td = taud \cdot \left(\sum_h (pf_h \cdot FF_h) \; + \sum_j FC_j\right)$$

7. The production tax revenue function

$$Tz_j = tauz_j \cdot pz_j \cdot Z_j$$

8. The import tariff revenue function

$$Tm_i = taum_i \cdot pm_j \cdot M_i$$

9. The government demand function

$$Xg_i = \frac{\mu_i \cdot \left(Td + \sum_j Tz_j + \sum_j Tm_j - Sg\right)}{pq_i}$$

Investment Behavior:

10. The investment demand function

$$Xg_i = \frac{\lambda_i \cdot (Sp + Sg + (\varepsilon \cdot Sf))}{pq_i}$$

Savings:

11. The private saving function

$$Sp = ssp \cdot \sum_h (pf_h \cdot FF_h)$$

In the model with increasing-returns-to-scale, the original unit cost function is modified as follows:

$$Sp = ssp \cdot \left(\sum_h (pf_h \cdot FF_h) + \sum_j FC_j\right)$$

12. The government saving function

$$Sg = ssg \cdot (Td + \sum_j Tz_j + \sum_j Tm_j)$$

Household (Private) Consumption:

13. The household demand function

$$Xp_i = \frac{\alpha_i \cdot (\sum_h (pf_h \cdot FF_h) - Sp - Td)}{pq_i}$$

In the model with increasing-returns-to-scale, the original unit cost function is modified as follows:

$$Xp_i = \frac{\alpha_i \cdot (\sum_h (pf_h \cdot FF_h) + \sum_j FC_j - Sp - Td)}{pq_i}$$

Trade:

14. The world export price equation

$$pe_i = \varepsilon \cdot pWe_i$$

15. The world import price equation

$$pm_i = \varepsilon \cdot pWm_i$$

16. The balance of payments

$$Sf = \sum_i (pWm_i \cdot M_i) - \sum_i (pWe_i \cdot E_i)$$

Armington Function:

17. The Armington function

$$Q_i = \gamma_i \cdot \left[\delta m_i \cdot M_i^{\eta_i} + \delta d_i \cdot D_i^{\eta_i}\right]^{\frac{1}{\eta_i}}$$

18. The import demand function

$$M_i = \left[\frac{\gamma_i^{\eta_i} \cdot \delta m_i \cdot pq_i}{(1+\tau m_i) \cdot pm_i}\right]^{\frac{1}{1-\eta_i}} \cdot Q_i$$

19. The domestic good demand function

$$D_i = \left[\frac{\gamma_i^{\eta_i} \cdot \delta d_i \cdot pq_i}{pd_i}\right]^{\frac{1}{1-\eta_i}} \cdot Q_i$$

Transformation Function:

20. The transformation function

$$Z_i = \theta_i \cdot \left[\xi e_i \cdot E_i^{\varphi_i} + \xi d_i \cdot D_i^{\varphi_i}\right]^{\frac{1}{\varphi_i}}$$

21. The domestic good supply function

$$D_i = \left[\frac{\theta_i^{\varphi_i} \cdot \xi d_i \cdot (1+\tau z_i) \cdot pz_i}{pd_i}\right]^{\frac{1}{1-\varphi_i}} \cdot Z_i$$

22. The export supply function

$$E_i = \left[\frac{\theta_i^{\varphi_i} \cdot \xi e_i \cdot (1+\tau z_i) \cdot pz_i}{pe_i}\right]^{\frac{1}{1-\varphi_i}} \cdot Z_i$$

Market clearing Condition:

23. The market clearing condition for composite good

$$Q_i = Xp_i + Xg_i + Xv_i + \sum_j X_{i,j}$$

In the 2009 SAM of Tompkins County from IMPLAN, the amounts of import and export goods are much larger than the amount of intermediate goods.

Therefore the definition of the market clearing condition for composite good is the combination of domestic and import goods:

$$pq_i * Q_i = pd_i * D_i + pm_i * M_i$$

24. The factor market clearing condition

$$\sum_j F_{h,j} = FF_h$$

Fictitious Objective Function:

25. The utility function

$$UU = \prod_i (Xp_i^{\alpha_i})$$

APPENDIX 2.4

The simulation of exogenous shock

	AGR	MIN	UTL	CON	MFG	WSALE	RETAIL
AGR	1.245555	0.001218	0.000844	0.001326	0.008565	0.000791	0.001251
MIN	0.00054	1.096925	0.010903	0.000972	0.005913	0.00029	0.000295
UTL	0.036433	0.038839	1.771372	0.02176	0.03659	0.025093	0.02759
CON	0.006511	0.018586	0.015749	1.97781	0.005489	0.005237	0.005569
MFG	0.010364	0.007835	0.005457	0.014119	1.061964	0.005939	0.004942
WSALE	0.02768	0.019138	0.014815	0.029735	0.038373	1.940162	0.016784
RETAIL	0.053487	0.056488	0.065418	0.110575	0.041475	0.0645	1.953093
TRANS	0.019994	0.018136	0.031311	0.018763	0.020786	0.034287	0.018808
INFO	0.008121	0.011759	0.013096	0.018862	0.011925	0.018121	0.014469
FIN	0.06278	0.053268	0.067087	0.05432	0.034874	0.072671	0.071099
RE	0.158321	0.116058	0.142994	0.125326	0.084128	0.150566	0.178258
PROSVC	0.033009	0.087265	0.070854	0.146416	0.061597	0.110713	0.064726
CORNELL	0.007006	0.004894	0.006499	0.005185	0.003497	0.006302	0.007562
UNIV	0.00466	0.003123	0.003827	0.003298	0.002223	0.003633	0.004704
ACCOM	0.00041	0.000304	0.000374	0.000328	0.00022	0.000393	0.000464
FOOD	0.030827	0.032393	0.0469	0.036269	0.025543	0.041833	0.045574
OTH	0.158986	0.189932	0.493088	0.189564	0.142027	0.234289	0.232482
LAB	0.465671	0.267403	0.401431	0.477875	0.319595	0.533045	0.652476
CAP	0.174883	0.429255	0.41548	0.215708	0.148181	0.236854	0.264433
IDT	0.035383	0.047132	0.123745	0.031612	0.027439	0.162964	0.199144
TRF	0	0	0	0	0	0	0
HHP	0.028847	0.031096	0.036828	0.031219	0.021066	0.03468	0.04128
HHM	0.190891	0.179508	0.222043	0.203665	0.137103	0.226485	0.271607
HHR	0.213944	0.231417	0.272751	0.231568	0.15621	0.257142	0.306185
FIRM	0.036783	0.089723	0.086935	0.045308	0.031119	0.049755	0.055585

The simulation of exogenous shock (Continued)

	TRANS	INFO	FIN	RE	PROSVC	CORNELL	UNIV
AGR	0.000816	0.000749	0.000844	0.000918	0.001128	0.001203	0.001203
MIN	0.000409	0.000316	0.000255	0.000323	0.000407	0.000851	0.000851
UTL	0.023135	0.022033	0.020631	0.025872	0.026691	0.115697	0.115697
CON	0.010803	0.008653	0.009105	0.03039	0.008372	0.005805	0.005805
MFG	0.009836	0.006629	0.004885	0.0044	0.016569	0.006987	0.006987
WSALE	0.018753	0.016836	0.013373	0.01241	0.017199	0.020888	0.020888
RETAIL	0.066387	0.059632	0.069575	0.068437	0.074925	0.076283	0.076283
TRANS	1.710847	0.017608	0.012951	0.009118	0.019708	0.015321	0.015321
INFO	0.014459	1.610312	0.022681	0.011281	0.106318	0.025369	0.025369
FIN	0.083371	0.062316	2.12687	0.162953	0.086853	0.066453	0.066453
RE	0.144694	0.144768	0.162205	2.164964	0.193054	0.243422	0.243422
PROSVC	0.061803	0.151014	0.116403	0.056323	1.940076	0.082218	0.082218
CORNELL	0.005666	0.005937	0.00621	0.005723	0.006857	1.045172	0.045172
UNIV	0.003605	0.003445	0.003969	0.00366	0.0043	0.004419	1.004419
ACCOM	0.000378	0.000379	0.000425	0.005494	0.000505	0.000631	0.000631
FOOD	0.04327	0.043338	0.056939	0.038928	0.064849	0.053208	0.053208
OTH	0.335686	0.232971	0.23825	0.221103	0.265298	0.271236	0.271236
LAB	0.506632	0.401709	0.471036	0.18858	0.641529	0.762742	0.762742
CAP	0.249046	0.342878	0.391189	0.651363	0.265429	0.149566	0.149566
IDT	0.057144	0.054603	0.046873	0.139354	0.045714	0.043763	0.043763
TRF	0	0	0	0	0	0	0
HHP	0.03412	0.033406	0.038661	0.037319	0.040861	0.04125	0.04125
HHM	0.220815	0.205652	0.238695	0.200619	0.268359	0.283804	0.283804
HHR	0.252653	0.248079	0.287201	0.278247	0.302958	0.30541	0.30541
FIRM	0.052281	0.071789	0.081912	0.136008	0.055786	0.031692	0.031692

The simulation of exogenous shock (Continued)

	ACCOM	FOOD	OTH	LAB	CAP	IDT	TRF
AGR	0.001141	0.002514	0.001261	0.00129	0.001046	0	0
MIN	0.000651	0.000422	0.001043	0.000327	0.000265	0	0
UTL	0.072091	0.042175	0.034057	0.027712	0.022402	0	0
CON	0.015423	0.006737	0.012817	0.005065	0.004165	0	0
MFG	0.006925	0.009364	0.007799	0.005908	0.004802	0	0
WSALE	0.017782	0.029442	0.021151	0.01863	0.01508	0	0
RETAIL	0.073118	0.068439	0.079566	0.109022	0.091177	0	0
TRANS	0.015903	0.015159	0.016516	0.012309	0.010132	0	0
INFO	0.026175	0.017777	0.020097	0.013608	0.011118	0	0
FIN	0.079113	0.067942	0.098275	0.079741	0.065609	0	0
RE	0.174732	0.172389	0.198725	0.222339	0.184041	0	0
PROSVC	0.14641	0.079801	0.089369	0.03868	0.031535	0	0
CORNELL	0.006567	0.005728	0.007034	0.009891	0.008303	0	0
UNIV	0.004186	0.003655	0.004496	0.006334	0.005318	0	0
ACCOM	1.000979	0.000449	0.000517	0.000582	0.000482	0	0
FOOD	0.074776	1.659659	0.052743	0.061792	0.050737	0	0
OTH	0.298748	0.231135	2.021269	0.304239	0.247143	0	0
LAB	0.667753	0.559518	0.703395	1.182925	0.149908	0	0
CAP	0.208632	0.210136	0.206314	0.115931	1.095518	0	0
IDT	0.058705	0.085554	0.028307	0.03057	0.025304	1	0
TRF	0	0	0	0	0	0	1
HHP	0.039582	0.034699	0.042725	0.05877	0.055099	0	0
HHM	0.26514	0.22954	0.283975	0.415125	0.281822	0	0
HHR	0.293152	0.257197	0.310067	0.435076	0.411583	0	0
FIRM	0.043954	0.044198	0.043493	0.024945	0.228642	0	0

The simulation of exogenous shock (Continued)

	HHP	HHM	HHR	FIRM	Investment	Change	%Change
AGR	0.002257	0.00199	0.001663	0.001276	0	0.000423	0.0005%
MIN	0.00061	0.000503	0.000416	0.000324	0	0.000149	0.0001%
UTL	0.055596	0.043263	0.034272	0.027508	0	0.011912	0.0032%
CON	0.008031	0.007292	0.007158	0.005027	0	0.013977	0.0039%
MFG	0.010312	0.008999	0.007735	0.005851	0	0.002026	0.0002%
WSALE	0.020424	0.028979	0.025415	0.0182	0	0.005716	0.0037%
RETAIL	0.15509	0.143401	0.169822	0.108679	**0.00059**	0.03262	0.0063%
TRANS	0.021808	0.017612	0.017194	0.012262	0	0.004204	0.0030%
INFO	0.023074	0.020215	0.018411	0.013494	0	0.005196	0.0025%
FIN	0.107322	0.114509	0.11553	0.078815	0	0.07497	0.0164%
RE	0.335952	0.309294	0.327069	0.220992	**0.459813**	0.995584	0.0918%
PROSVC	0.061332	0.058086	0.052288	0.038244	0	0.025936	0.0039%
CORNELL	0.031286	0.012661	0.013444	0.010183	0	0.002636	0.0002%
UNIV	0.02007	0.008104	0.008609	0.006522	0	0.001686	0.0002%
ACCOM	0.000889	0.000807	0.000856	0.000578	0	0.002526	0.0016%
FOOD	0.092428	0.089616	0.087412	0.061185	0	0.017927	0.0039%
OTH	0.526825	0.464624	0.397665	0.301133	0	0.101803	0.0040%
LAB	0.308769	0.267727	0.251652	0.181603	0	0.087097	0.0031%
CAP	0.179205	0.165195	0.166121	0.115067	0	0.299661	0.0282%
IDT	0.045785	0.042523	0.045025	0.030377	0	0.064194	0.0292%
TRF	0	0	0	0	0	0	0.0000%
HHP	1.023106	0.020586	0.021654	0.078467	0	0.017184	0.0034%
HHM	0.145262	1.128553	0.13103	0.371608	0	0.092407	**0.0063%**
HHR	0.168593	0.15008	1.155003	0.450692	0	0.128122	**0.0083%**
FIRM	0.037584	0.034635	0.034818	1.024122	0	0.062571	**0.0214%**
Total					**0.460403**	**2.050528**	**0.2454%**

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CHAPTER 3

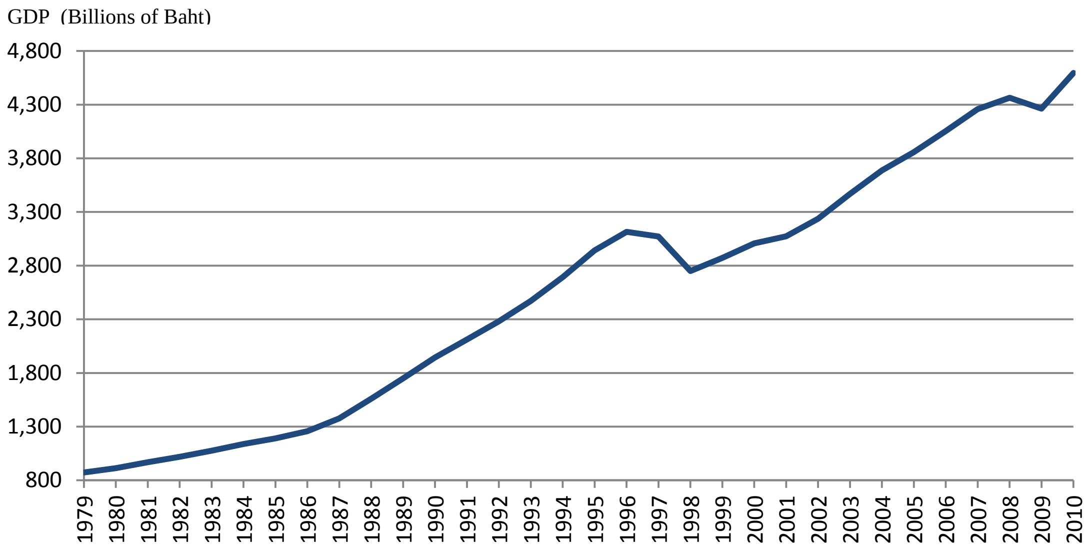
THE ROLE OF REAL ESTATE IN THE ECONOMY OF THAILAND:

A FINANCIAL COMPUTABLE GENERAL EQUILIBRIUM APPROACH

3.1 Introduction

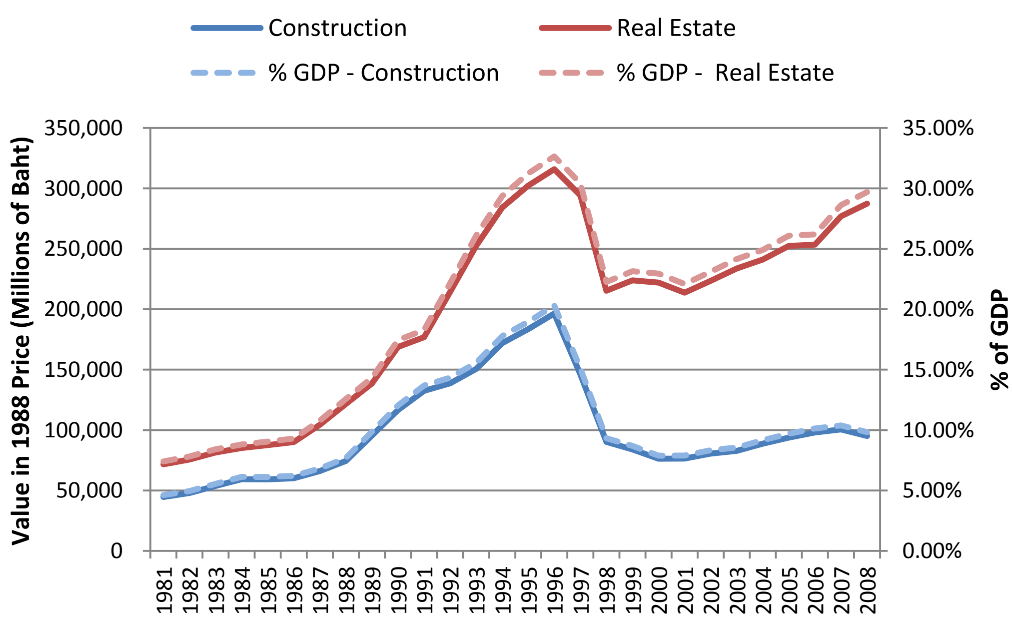
The real estate sector and the financial sector are indeed highly interconnected. As one can see, the 1997 financial crisis in Thailand originally stemmed from overinvestment in the real estate sector. To examine the role of real estate in the economy, an economy-wide analytical framework that can capture interrelations among various economic sectors, including production sectors, households, government, and financial sectors, like a Financial Computable General Equilibrium (FCGE) model is needed. Yet, little has been done to methodically link the real estate sector to the financial sector. In this study, a FCGE model of Thailand, which explicitly connects the real estate sector to the financial sector, is used to analyze the importance of the real estate sector in Thai economy. To the best of my knowledge, this study is one of the first few attempts to analyze the economy-wide impacts of the real estate sector using a FCGE framework for an emerging market like Thailand.

Thailand was regarded as an example of the so-called "East Asian Economic Miracle." In 1986-1996, with the average of 10% annual growth of gross domestic product (GDP), it was the fastest growing economy in the world, as shown in Figure 3.1. With adequate labor resources, relative low land prices and labor costs, as well as various preferential financial and monetary policies, Thailand attracted large amounts of capital from many developed countries. One of the countries that heavily invested in Thailand was Japan, which, in the late 1980s, began to export large-scale capital to Southeast Asian countries due to the appreciation of the Yen and the collapse of the economic bubble.



Source: Bank of Thailand, March 2011

Figure 3.1: Gross Domestic Product (GDP) of Thailand from 1988-2010



Source: Office of the National Economic and Social Development Board

Figure 3.2: Value and Percent Share of GDP of Real Estate and Construction Sector, 1981-2008

In order to increase capital for improving utilities and infrastructures as well as funding export-oriented industries, the Thai Government adopted a series of preferential financial and monetary policies to accelerate the reform of financial liberalization, and expand offshore financial business. These policies rapidly expanded the domestic investment and credit in Thailand. However, most loans, especially personal loans, did not flow into the production sectors but rather into the stock market and real estate speculation. Moreover, the excessive expansion of bank credit fueled bubbles in the real estate industry and the economy of Thailand.

This paper analyzes the risks and benefits from additional investment in real estate in Thailand using a FCGE model. It argues that investment in real estate provides both risks and benefits to the Thai economy but in less degree than the investment in two other major sectors in Thailand, agriculture and manufacturing. The chapter proceeds with reviews of the relevant stylized facts of Thailand and literature on real estate and economy. Data used in this study are then described, followed by the discussion of methodology. The chapter concludes with the presentation of simulation results and discussion of policy implications.

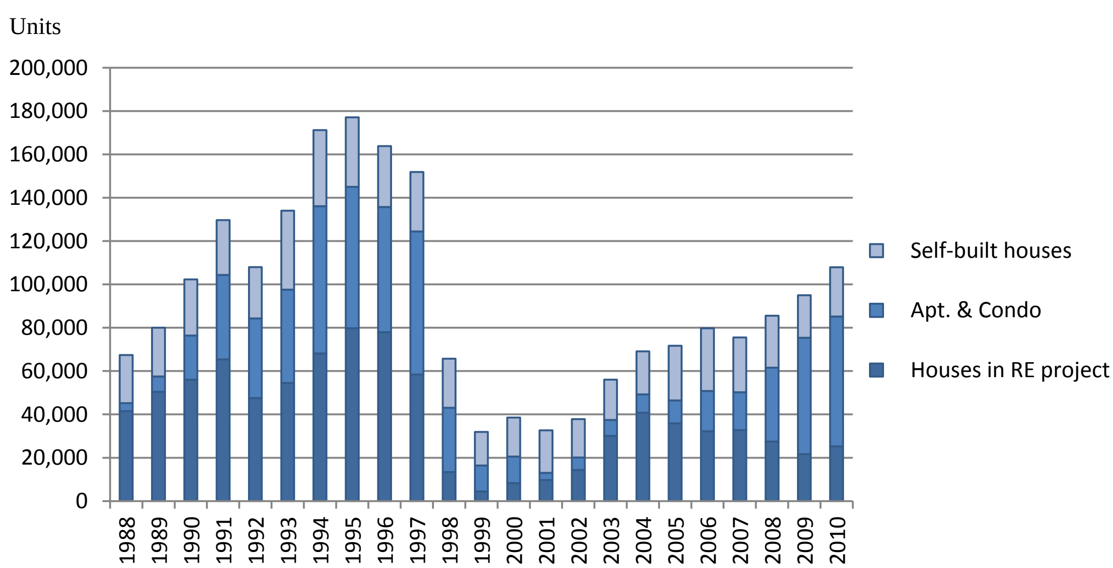
3.2 Literature Review

3.2.1 Real estate and macroeconomic growth

The real estate industry has contributed to the growth of Thailand in a rapidly growing economy during the boom decade. During the high-growth period, the industry accounted for almost one-third of the country's GDP (see Figure 3.2). In addition, the construction sector, which is a real-estate-related industry, constituted about 20 percent of the growth in GDP. Altogether, real estate and its related industry were large contributor to the growth of Thai economy during the boom period.

Nonetheless, overvalued and speculated real estate market was one of the major factors causing the financial crisis in Thailand, leading to the contagion effects of the 1997 Asian financial crisis. The Thai currency, Baht, which has been pegged to the US dollar since the 1950s, collapsed in 1997. Then the exchange rate was floated in July 1997. The confidence of both its citizens and foreigners in the economy was shattered and poverty increased significantly. Both real estate and construction sectors suddenly collapsed right after the 1997 crisis.

Considered to be highly correlated with the economic growth, the degree of the real estate investment can be represented by newly-built housing units, as shown in Figure 3.3. Due to the prolonged nature of the real estate development process, the industry was usually lagging behind other sectors. Not until 2001—four years after the crisis—did the real estate market began to recover. In 2004, the numbers of newly-built housing units were greater than the level at the beginning of the financial meltdown. However, the market slightly slowed down during 2006 and 2007 due to the political problems in Thailand.



Source: Bank of Thailand, April 2011

Figure 3.3: Newly-built Housing Units in BMR from 1988-2010

In 2008, the global financial crisis caused by the real estate bubble in the US was expected to affect the real estate industry in Thailand. However, it did not hit the Thai economy as hard as many expected. Learning a valuable lesson from the crises, Thai real estate developers and investors have become more professional and more cautious about overinvesting. In addition, the banking and financial industries have provided loans to both developers and consumers with much more careful consideration. The property speculation as well as consumer confidence are also low due to unstable political and economic situations. Thus, the real estate market has continued to grow steadily, and property prices have been quite stable.

As mentioned earlier, the data on newly-built housing units can be a good representative of real estate investment. Before 2000, however, the data of nationwide newly-built housing units were not available. The 2001-2010 data of newly-built units are available only for the Bangkok Metropolitan Region (BMR), which is the major real estate development region in Thailand. In 1989-2000, real estate development in the BMR accounted for more than 62% of the development in the country. Therefore, in this study, the data of new housing units in BMR will be used as proxies of real estate investment in Thailand.

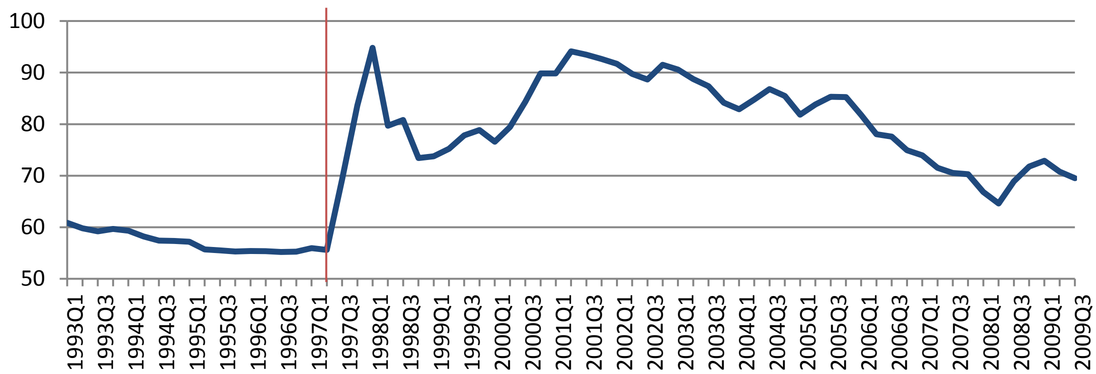
Even though the 2008 global financial crisis might not have had significant effects on the Thai economy, there have been direct and indirect impacts on both demand and supply in the real estate market. On the demand side, the 2008 crisis decreased disposable incomes of Thai households. The overall economy of Thailand, especially the export-based sectors, was impacted by the global economy, which in turn affected consumer confidence, income, and saving, resulting in lower disposable incomes. Further, the demand for real estate in Thailand comes from both local residents and expatriates. Due to the weak global economy, the housing demand from foreigners has decreased. Moreover, mortgage loans have been increasingly difficult to acquire. The prospective home buyers, as a result, have delayed their home buying decisions. On the supply side, developers have lowered their risks by reducing housing supply and constructing fewer housing units.

3.2.2 The Degree of Vulnerability to the 1997 Crisis

After 1997, many studies have investigated the economic phenomena before and during the crisis. Azis (2002) suggests the variables signaling the degree of vulnerability to a crisis, which include: 1) real exchange rate (RER) appreciation, 2) lending boom, and 3) low level of foreign exchange reserve.

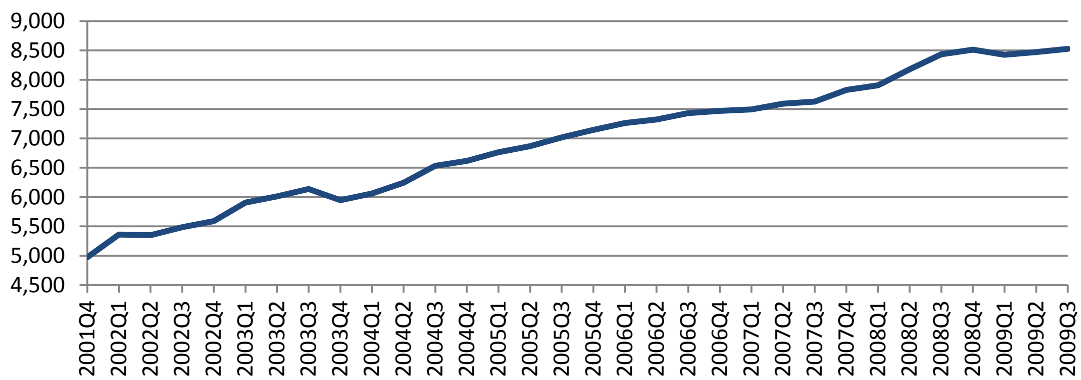
The fixed exchange rate regime was used in the period prior to 1997; therefore, the Thai Baht did not appreciate significantly before the crisis. As Thailand's current account balance was in deficit for a long period before the crisis, theoretically the Thai Baht was under pressure of depreciation. However, we observed that in fact the Thai Baht appreciated, indicating a large amount of capital inflow before 1997. During the crisis, the Thai Baht was attacked by currency speculators, resulting in sharp depreciation in RER. Within a year, the RER dramatically increased from 55 THB to 95 THB per US$ in real term. Thailand then fell into the financial crisis. Consequently, after the crisis, the Thai Baht real exchange rate appreciated during 1998-1999, and then depreciated again during 1999-2001. Since 2001, the Thai Baht real exchange rate has appreciated steadily and considerably. However, the value of Thai Baht never reached the same level as in the early 1990s (See Figure 3.4).

One of the indicators of a lending boom is claims on private sector. The data on credit from banking deposits for Thailand, unfortunately, are available only after 2001. Thus, the data measure for Thailand in the 1997 crisis cannot be observed. After the crisis, claims on the private sector steadily grew especially after 2001 (see Figure 3.5).



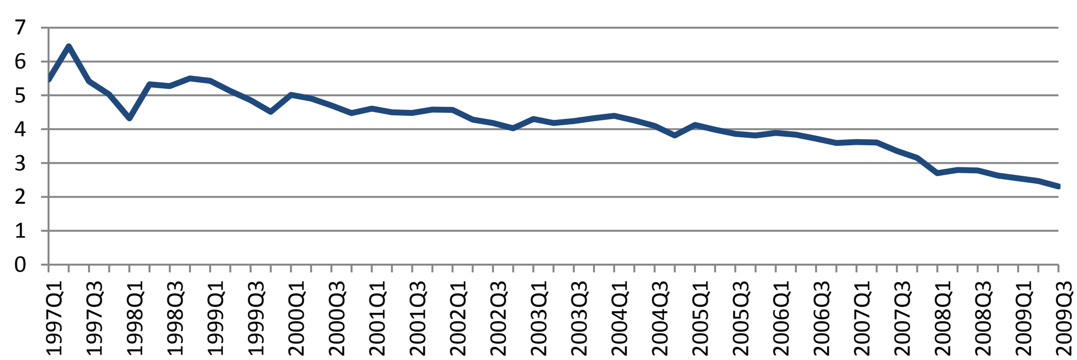
Source: The Economist Intelligence Unit Database

Figure 3.4: Thailand - Real Exchange Rate (THB/US$), 1993-2009



Source: International Financial Statistics, IMF

Figure 3.5: Thailand - Claims on private sector (Billion THB), 2001-2009



Source: The Economist Intelligence Unit Database

Figure 3.6: Thailand - M2/Foreign Reserves, 1997 – 2009

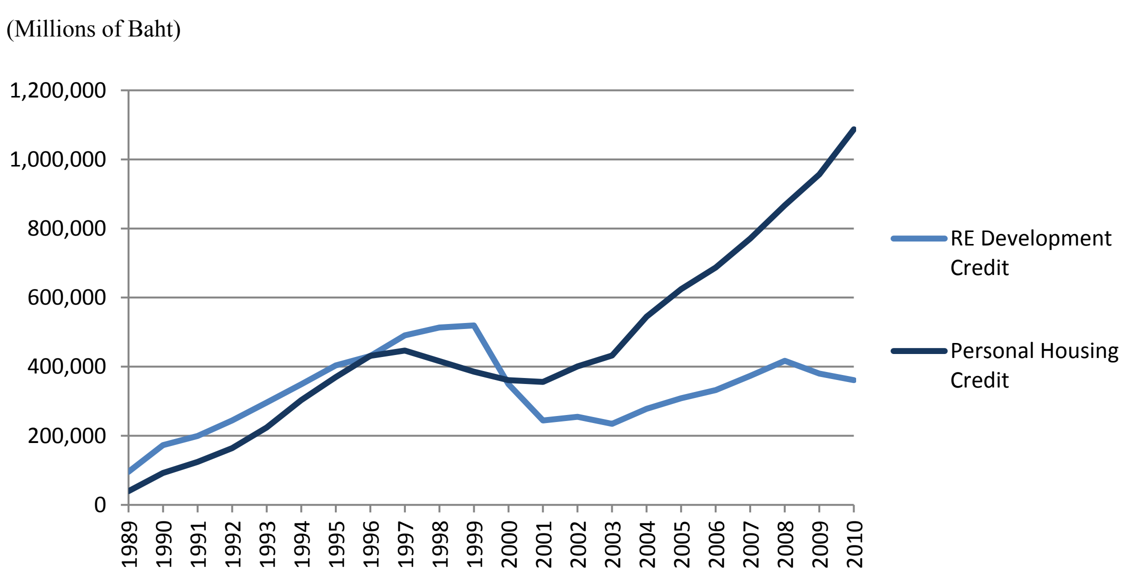
Finally, the third measure can be analyzed by using a ratio of broad money (M2) to foreign exchange reserve as it indicates the degree to what extend people can convert their local currency into foreign currency. The ratio increased sharply in 1997 (see Figure 3.6), indicating high vulnerability to a crisis. The ratio has gradually declined since 1998. A look back at these historical data suggests that these three indicators of vulnerability to financial crisis can signal overheating economic growth to some extent. Therefore, this study uses these three indicators to measure the degree of vulnerability to another crisis.

3.2.3 Real estate development in the BMR

As the political, cultural, and economic capital of Thailand, the Bangkok Metropolitan Region (BMR) is one of the most populated regions in the world. Its urban structure has been dominated by the expanding network of arterial roads and ring roads since the 1960s. Due to the fact that transportation policies in the past concentrated mostly on construction of new roads rather than on traffic management, traffic congestion has become one of the most crucial problems of Bangkok (Daniere, 1995). In order to ease the chronic traffic congestion in Bangkok, the first mass transit system in Bangkok, BTS Skytrain, was introduced in the late 1990's. Soon after, MRT Subway started their operations in 2004. These mass transit systems have not only alleviated traffic problems, but also intensified real estate development, especially along the transit lines.

Real estate developers have also played an increasing role in the real estate supply in the BMR, in particular housing in real estate projects and condominiums. In 1984, only 12 percent of housing units in the BMR were developer-built units (Dowall, 1989). Since 1988, the number of new housing units built by real estate developers has been the majority of all new housing units. In 2010, developer-built housing units accounted for approximately 80% of all new units in BMR.

Figure 3.7 illustrates the value of outstanding credits of both real estate development and personal housing units from 1989 to 2010. Prior to 2000, real estate development credits exceeded personal housing credits. The real estate development credits peaked in 1999, a few years after the crisis, and dropped dramatically afterwards. After the 1997 crisis, financial institutions and real estate developers learned some lessons. The values of real estate development outstanding credits have been lower than the personal housing credits since the beginning of economic recovery. On the other hand, personal housing credits have been dramatically increased which may be the impacts of government housing policies since 2001. Even though the outstanding credits of developers are low, the high values of personal housing credits are still very high.



Source: Bank of Thailand, April 2011

Figure 3.7: Newly Property Credit Outstanding from 1989-2010

3.2.4 Property and Asset Markets

Pholphirul and Rukumnuaykit (2009) estimate the duration of the real estate cycle in Thailand to be approximately 69 months. The major leading indicators for the real estate cycle are construction price index, money supply (M2), property stock index and post-credit finance. They also find evidence that the real estate cycle in expansion periods is always found to lead the business/economic cycle of Thailand. The real estate business cycle in general can be explained by DiPasquale and Wheaton (1992). They suggest a simple analytical framework of a four-quadrant diagram explaining connections between the space market (property market) and real estate asset market. In this study, the framework of DiPasquale and Wheaton (1992) is incorporated as an extension of the standard FCGE model. Figure 3.8 depicts the relationship between the two markets.

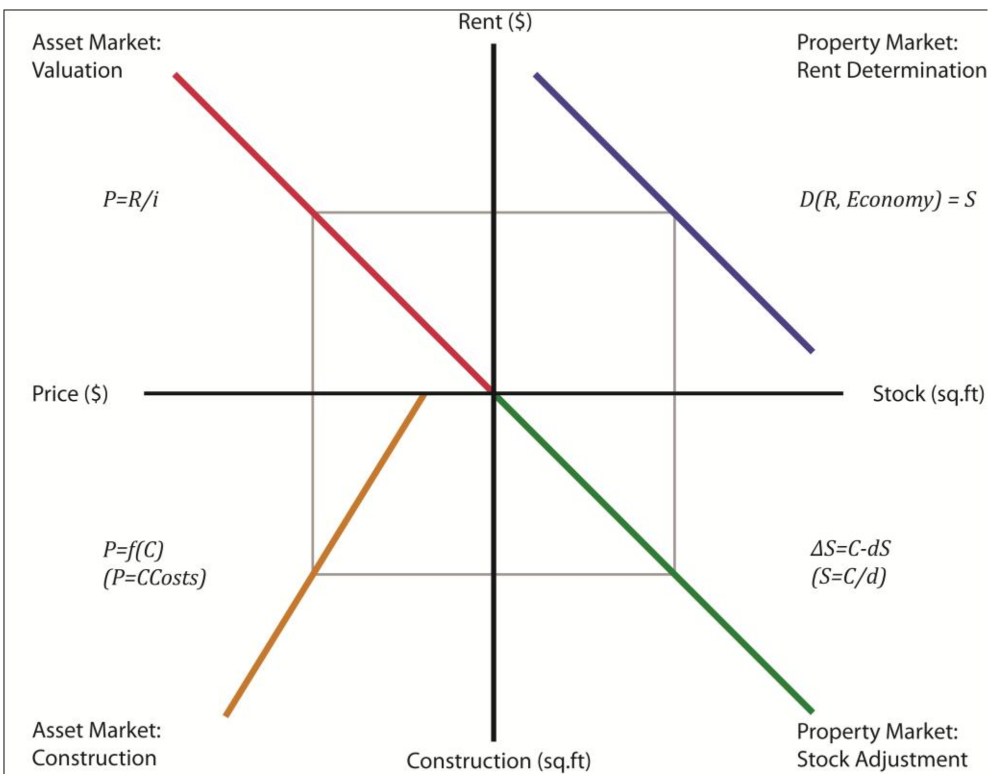


Figure 3.8: The relationship between property and asset markets

In the framework of DiPasquale and Wheaton (1992), rents in the short run are determined by the demand for space which is equal to the stock of space in equilibrium, shown in the property market quadrant (the northeast quadrant). The rent determination can be represented in the following equation:

$$D(R, Economy) = S,$$

where D is a demand for space, R is a rent, Economy is economic factors, and S is the stock of space. DiPasquale and Wheaton (1994) also suggest that the supply of housing can be represented in the following equation:

$$D(X, P, U, R) = S,$$

where demographic characteristics and real permanent income (X), housing price (P), cost of financing (U), and the alternative cost of renting (R).

Subsequently, in the asset market (the northwest quadrant), the rent determines a price for real estate asset according to a capitalization rate, which includes the long-term interest rate, expected growth in rents, risks associated with rental income stream, and the treatment of real estate in the tax code. The real estate valuation in the asset market can be represented in the following equation:

$$P = R/i,$$

where P is a price for real estate asset, R is rents, and i is a capitalization rate.

In the asset market (the southwest quadrant), the price of real estate assets is related to the replacement or construction costs. In the long run, the price of real estate in the asset market should be equal to construction costs in the equilibrium. The real estate construction in the asset market can be represented in the following equation:

$$P = f(c),$$

where P is a price of real estate asset, and f(c) is a function of replacement cost. The connections from the asset market are then back to the property market through the relation of construction costs and a long-run stock of real estate space (the southeast quadrant). The stock depending on construction costs and the depreciation rate of stock will determine rents (NE quadrant). The stock adjustment of space in the property market can be represented in the following equation:

$$\Delta S = C - dS,$$

where S is a long-run stock of real estate space, d is a the depreciation rate of stock, and C is new construction.

3.3 Data

Two main sources of data are used in this study: the financial social accounting matrix (FSAM) and real estate market data of Thailand. These data sources are used as the input of the FCGE model. Almost all parameters and initial variables in the model are calibrated from these data.

3.3.1 Financial social accounting matrix

The 2007 FSAM of Thailand produced by the National Economic and Social Development Board (NESDB) and Fiscal Policy Research Institute (FPRI), is used as the major database for the FCGE model in this study. The 71-account FSAM consists of:

- Fifteen production sectors: agriculture, fishery, mining & quarrying, manufacturing, electricity & water supply, construction, wholesale & retail trade, hotel & restaurant, transportation & communication, financial intermediation, real estate and renting, public administration & defense, education, health, and other services,
- Five households which are grouped into poor and non –poor households
- A private firm, state-owned enterprise, financial institutions, government, and rest-of-the-world,

- Ten financial instruments: cash, deposits, loans and bills, government bonds, corporate bonds, listed equity, foreign assets/liabilities, non-listed equity, other items, and FOREX reserve.

Similar to the structure of SAM (see Figure 3.9), the capital account in FSAM is disaggregated into ten sectors of financial instruments as well as into capital accounts of each institution based on the information of flow of funds. Figure 3.10 illustrates the structure of the FSAM in this study. The detail description of sectors in the FSAM used in the FCGE model is also shown in Appendix 3.1. The 2007 FSAM of Thailand is shown in Appendix 3.3.

3.3.2 Data of real estate market in Thailand

The main data source of real estate in Thailand is from the Real Estate Information Center (REIC), which is an organization established by the Government Housing Bank (GHB). Another source of information on the real estate market of Thailand is Fiscal Policy Research Institute (FPRI), which is a non-profit organization under the policy supervision by the Ministry of Finance. Table 3.1 and Table 3.2, respectively, show the market value of real estate and number of housing units in Thailand from 2003 to 2007. The changes of the value of real estate and the change in number of housing in 2004 are approximately 30% and 13%, respectively. After 2004, however, the lower changes in market value and number of housing after 2004 may suggest stability of the real estate market in Thailand.

<table>
<tr><th></th><th>Production</th><th>Factors</th><th>HH</th><th>Firms</th><th>Gov</th><th>ROW</th><th>Tariff</th><th>Taxes</th><th>KA</th></tr>
<tr><td>Production</td><td>Intermediate Inputs</td><td></td><td>HH Consumption</td><td></td><td>Gov Consumption</td><td></td><td></td><td></td><td>Investment</td></tr>
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Figure 3.9: The structure of Social Accounting Matrix (SAM)

<table>
<tr><th></th><th>Production</th><th>Factors</th><th>HH</th><th>Firms</th><th>Gov</th><th>ROW</th><th>Tariff</th><th>Taxes</th><th>KA_HH</th><th>KA_Firms</th><th>KA_Gov</th><th>KA_ROW</th><th>Assets</th><th>Assets</th></tr>
<tr><th>Production</th><td>Intermediate Inputs</td><td></td><td>HH Consumption</td><td></td><td>Gov Consumption</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Investment</td><td></td></tr>
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<tr><th>Firms</th><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Firm ΔLiabilities</td></tr>
<tr><th>Gov</th><td></td><td>Tariff Revenue</td><td>Taxes Revenue</td><td></td><td></td><td></td><td></td><td></td><td>Gov ΔLiabilities</td></tr>
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<tr><th>KA_Gov</th><td></td><td></td><td></td><td></td><td>Gov Saving</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><th>KA_ROW</th><td></td><td></td><td></td><td></td><td></td><td>ROW Saving</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><th>Fixed Assets</th><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>HH Investment</td><td>Firm Investment</td><td>Gov Investment</td><td>ROW Investment</td><td></td><td></td></tr>
<tr><th>Financial Assets</th><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>HH ΔAssets</td><td>Firm ΔAssets</td><td>Gov ΔAssets</td><td>ROW ΔAssets</td><td></td><td></td></tr>
</table>

Figure 3.10: The structure of Financial Social Accounting Matrix (FSAM)

Table 3.1: The market value of real estate in Thailand, 2003-2007

Values (Billion Baht)	2003	2004	2005	2006	2007
New Housing	146,132	208,343	246,750	281,668	311,738
		42.60%	18.40%	14.20%	10.70%
Pre-owned housing	29,619	28,489	29,055	30,852	32,900
		-3.80%	2.00%	6.20%	6.60%
Custom-Built housing	55,215	62,648	69,523	75,952	82,983
		13.50%	11.00%	9.20%	9.30%
Total	230,967	299,480	345,328	388,472	427,622
Change		29.70%	15.30%	12.50%	10.10%

Table 3.2: The number of housing unit in Thailand 2003-2007

Unit	2003	2004	2005	2006	2007
New Housing	46,052	59,409	68,025	73,838	78,684
		29.00%	14.50%	8.50%	6.60%
Pre-owned housing	25,717	23,998	23,443	23,346	23,356
		-6.70%	-2.30%	-0.40%	0.00%
Custom-Built housing	90,902	100,170	107,741	113,786	120,174
		10.20%	7.60%	5.60%	5.60%
Total	162,671	183,577	199,209	210,970	222,215
Change		12.90%	8.50%	5.90%	5.30%

Source: Fiscal Policy Research Institute (FPRI)

3.4 Methodology

This study employs the Computable General Equilibrium (CGE) model framework based on a Financial Social Accounting Matrix (FSAM) of Thailand, to analyze the role of real estate in the economy. The CGE model is then developed into the framework of a standard Financial Computable General Equilibrium (FCGE) model based on the model developed by Nattapong (2009). The principle assumption underpinning FCGE models is the balance between total assets and liabilities held by each institution during a given period of time. FCGE models simulate theoretical behaviors of institutions in the financial market through a system of equations. The general equilibrium is achieved when all conditions and constraints hold.

This study also incorporates the FCGE model with the theoretical framework relation of property and asset market by DiPasquale and Wheaton (1992). This model is developed to measure the economy-wide impact on real and financial sectors in the economy due to real estate investment. The results of the model suggest policy implication of socio-economic impact of real estate investments, and the degree of vulnerability to the crisis is evaluated by macroeconomic indicators from the model.

3.4.1 Computable general equilibrium

To examine the effect of real estate investment in the economy, the CGE model is used to explore the economy-wide impacts. The CGE model is based on the general equilibrium theory of the competitive market economy and the price mechanism. In the CGE model, a representative household determines its consumption bundles to maximize its utility subject to a budget constraint while a firm maximizes its profits by managing its inputs and outputs subject to its production technology. Based on optimized behaviors, the demand and supply of goods and factors of production are equilibrated in the markets by price adjustment.

The model involves optimizing behaviors of economic agents under given resource and technology constraints, and under indicators from market prices. In this study, the following are key specifications of this CGE model:

- There are 15 production sectors including the real estate and construction sectors, two types factors of production (labor and capital), three types of taxes (income tax, indirect tax, and tariff), and 10 institutions (five household groups, private-owned enterprise, state-owned enterprise, financial institution, and government, and the rest of the world).
- The exchange rate is an endogenous variable.
- Foreign saving is treated exogenously.

- While the government saving is endogenous, the government consumption is exogenous. Government subsidy and expenditure are exogenous.
- Capital is mobile and fully employed, and labor is also mobile. Wages are set endogenously.

The framework of the CGE model can be represented in Figure 10. The nested structure represents the connection between production and goods markets. The intermediate goods (INTM) and the value-added of production (VA), which is created by Labor (L), and capital (K), are employed to produce the output (X). Some outputs will be exported as the export (E) and some will be sold domestically (D). The proportion of exported and domestic goods is controlled by the function of Constant Elasticity of Transformation (CET). The domestic goods and imported goods are used to produce composite goods to serve domestic demands. The proportion of imported and domestic goods is controlled by the function of Constant Elasticity of Substitution (CES). The values of imported and exported goods are accounted as a foreign saving (SAVROW).

The incomes of private institutions (YPriv), such as households and firms, are from factors of production and institutional transfers. Government revenues (YGov) are from taxes and tariff, and institutional transfers. Based on the marginal propensity to consume, the revenues of each institution will be allocated for savings and consumption. The total savings consist of private saving (SAVPriv), government saving (SAVGov), and foreign saving (SAVROW). The consumption and investment behaviors of private institutions (Cpriv) and government (CGov), based on the Cobb-Douglas utility function, are determined by prices of goods, and disposable incomes. In this economy, the assumption of balance of total saving and investment (INVEST) must hold.

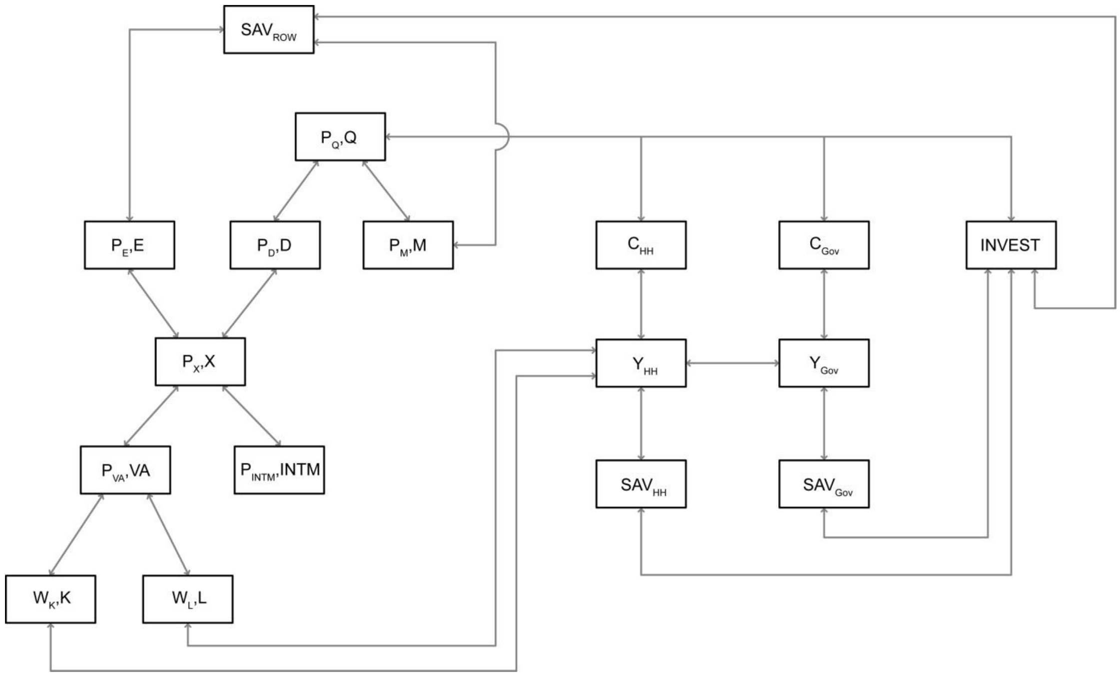

Figure 3.11: The structure of Computable General Equilibrium (CGE)

3.4.2 Financial computable general equilibrium

3.4.2.1 Standard FCGE model

The FCGE model framework is an extension of the CGE model incorporating the flow of funds account. Vongpradhip (1987) and Rosensweig and Taylor (1990) were among the pioneers who developed a FCGE for Thailand. Consequently, influenced by the studies of Azis (2002) and Mansury (2002) on the economy of Indonesia, Manopiniwes (2005) and Puttanapong (2008) developed FCGE models for Thailand using SAM of Thailand and the flow of funds accounts in 2004.

Similar to the framework of Manopiniwes (2005) and Puttanapong (2008), this study presents the FCGE model for Thailand, using the 2007 FSAM as its base year data. The model replicates the activities in the real economy and financial transactions in Thai economy. As an extension of the CGE model, the mechanism of the financial module is included (see Figure 3.12). The following aspects are additional key specifications of this FCGE model:

- Balancing the balance sheets and equilibrating demand and supply of assets
- Saving and investment linkage between the real and financial markets
- Transmission of monetary policy
- Portfolio choices of institutions

In addition, this study focuses on the real estate sector in the economy of Thailand. Therefore, the framework of DiPasquale and Wheaton (1992) on the real estate market will be included as the incorporated equations of relationship between asset and property markets represent the role of real estate, especially in residential development, in Thailand.

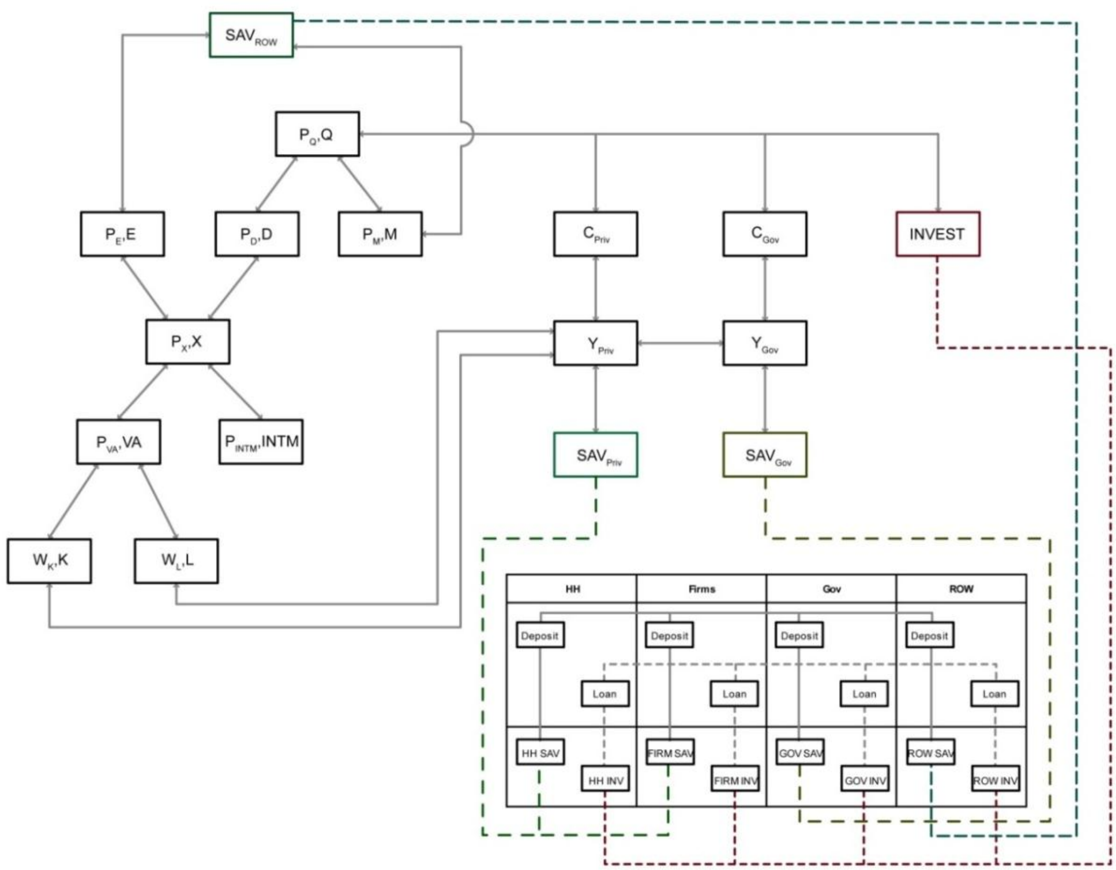

Figure 3.12: The structure of Financial Computable General Equilibrium

3.4.2.2 Asset allocation

One important aspect in the FCGE model in this study is that households' asset allocation—representing households' investment behavior in the financial market—is incorporated explicitly in the model. Following previous studies using FCGE models, the specification of households' asset allocation is based on the theoretical framework of portfolio allocations by Tobin (1979); Brunner and Meltzer (1972); Bernanke and Blinder (1988); Bouguignon, Branson, and de Melo (1989); Thorbecke et al. (1992); and Azis (2002). It is assumed that there is no perfect substitutability in household portfolio allocation, and the allocation to a particular kind of asset is driven by the rate of return of such asset.

Since wealth is considered a stock (as opposed to a flow), households need to allocate their amount of wealth to different kinds of assets. Due to the limitation of data, household's wealth may be allocated between two main types of financial assets—money demand and non-money demand. The proportion of the allocation is represented by an asset allocation parameter (gh1), which is determined primarily by the average rate of return of money demand (avgRNmd) and of non-money demand (avgRNnmd). These allocation behaviors are shown in Equations C5 to C7 in the Appendix 3.2.

3.4.2.3 Relationship of property and asset markets

As discussed previously in the literature review section, DiPasquale and Wheaton (1994) study the behavior in the housing market in the US by applying the framework of the relationship between property and asset markets (DiPasquale and Wheaton, 1992). In this study, the equations of the four quadrants from the framework are incorporated into the FCGE model.

In the property market quadrant (the northeast quadrant), the supply of housing is represented by the stock of housing in Thailand. The function of demand for space is determined by RGDP, price of real estate sector (PQ_{SEC11}), and average rate of return (avgRN). Equation C8 representing this demand function is shown in the Appendix 3.2. In the asset market (the northwest quadrant), a price for real estate asset is determined by capitalization rate. The real estate valuation in the FCGE model, Equation C9, represents a price for real estate asset (PAsset), which is determined by the average rate of return (avgRN) and the rate of return of real estate sector (RNRE).

In the asset market (the southwest quadrant), the price of real estate assets is related to the replacement or construction costs. In this study, the replacement cost is related to a price of construction sector (PQ_{SEC6}). Equation C10 represents the relationship of the asset market in this quadrant. In the southeast quadrant, the stock of real estate at the end of the year depends on construction costs and the depreciation rate of stock. In the FCGE model, the stock adjustment of space in the property market (restock) can be represented as a function of construction cost, the depreciation rate of stock (redep), and the quantity of real estate (Q_{SEC11}).

3.5 Results

3.5.1 Simulation and results

The FCGE model is used to simulate the impact of real estate investment on the economy of Thailand. This model is based on the 2007 Thailand FSAM, which provides rich information of economic activities and structure such as income distribution, transfers among institutions, production and consumption patterns, saving and investment, and flow of funds. The fact that the model is economy-wide and price-endogenous makes the FCGE model suitable for analyzing the effect of real estate investment on not only macroeconomic fundamentals but also on social factors, especially on income distribution.

In this study, the risks and opportunities from high investment speculation in real estate is examined. There are four simulation scenarios are undertaken: (1) baseline, additional five percent increase annually in an investment in (2) real estate (scenario RE), (3) agriculture (scenario AG), and (4) manufacturing sectors (scenario MGR). The baseline simulation scenario is assumed that there is the annual growth of 3.5% in real estate investment in Thailand. Three other scenarios are assumed that there is additional five percent increase in an investment from a rich household in alternate sectors, which represents speculative behavior. The time frame of the simulation is 10 years. Both the risks and opportunities from the high speculation are measured from the simulation results.

The risk, so called the vulnerability to a crisis, is analyzed. In this study, the simulation results can provide only two out of three indicators: real exchange rate (RER) appreciation and the level of foreign exchange reserve. On the other hand, the opportunity is indicated by macroeconomic fundamentals, such as GDP, Real GDP (RGDP), Price Index (PINDEX), exchange rate (EXR), as well as socio-economic indicators, such as incomes of the poor (INC.Poor) and non-poor (INC.NPoor), income distribution (INC.Dist), and unemployment rate (UEMPR). The income distribution is measured by the ratio of the incomes of the poor to those of the non-poor household.

In the baseline scenario, the simulation results show that the annual growth of 3.5% in real estate contributes to a slight increase of the vulnerability to crisis as shown in Figure 3.13. The RER and the M2/Foreign exchange reserve ratio suggest a heightened risk to economic instability. In terms of opportunity, the results suggest that there is evidence of economic growth with real estate investment as the GDP and

RGDP increases. The results, however, show a trade-off between the higher growth and higher inflation (PINDEX). Moreover, currency appreciation may make foreign investment less attractive in Thailand and hurt export-oriented sectors.

Figure 3.13 shows the impact in term of social indicators. The results suggest a positive impact on the incomes of all household groups and a lower unemployment rate. However, the impact is not evenly distributed as the income distribution indicator worsens.

In comparison to the baseline, currency in real terms depreciates in all three scenarios. The real exchange rate depreciates the most in Scenario MFG, followed by Scenario AG and RE, respectively. This result suggests that a 5 percent increase in investment in the real estate sector puts the least pressure on currency depreciation when compared to the same growth in investment in agriculture and manufacturing sectors. The M2/FOREX ratio in Scenario AG is the highest, followed closely by the ratio in Scenario MFG. These indicators suggest that 5 percent additional investment in real estate does not impose risk to crisis as high as in agriculture and manufacturing sectors.

Figure 3.14 shows the simulation results in terms of macroeconomic performance. GDP in Scenario AG is the highest among the three scenarios, followed by Scenario MFG and RE. This result conforms to the stylized fact that both agriculture and manufacturing are predominant sectors in Thailand. However, in real terms Scenario MFG yields the highest RGDP, followed by Scenario RE and AG. Additional investment in the agriculture sector puts an upward pressure on price the most, resulting in lower RGDP. In terms of average commodity price (PINDEX), Scenario AG has the highest inflation, followed by Scenarios MFG and RE. Similarly for the nominal exchange rate, Scenario AG has the highest degree of currency depreciation, followed by Scenarios MFG and RE. These macroeconomic indicators suggest that investment in agriculture sector may lead to the highest growth, but the benefit is offset by the increase in price. Additional investment in the real estate sector, on the other hand, leads to lower growth, but lower inflation as well.

In terms of social indicators, Figure 3.15 shows the simulation results of the baseline and three scenarios. Scenario AG has the highest growth in income of the poor, followed by Scenarios MFG and RE. Both Scenarios MFG and AG have similar positive impact on income of the non-poor households, followed by Scenario RE. Additional investment in the real estate sector does not improve household income as much as in agriculture and manufacturing sectors. Scenario AG shows the improvement in income distribution while the distribution worsens in both Scenarios MFG and RE. The unemployment rate improves the most in Scenario MFG, followed by Scenarios AG and RE. Additional investment in real estate sector does not improve income distribution as much as in agriculture sector nor reduce unemployment rate as much as in manufacturing sectors.

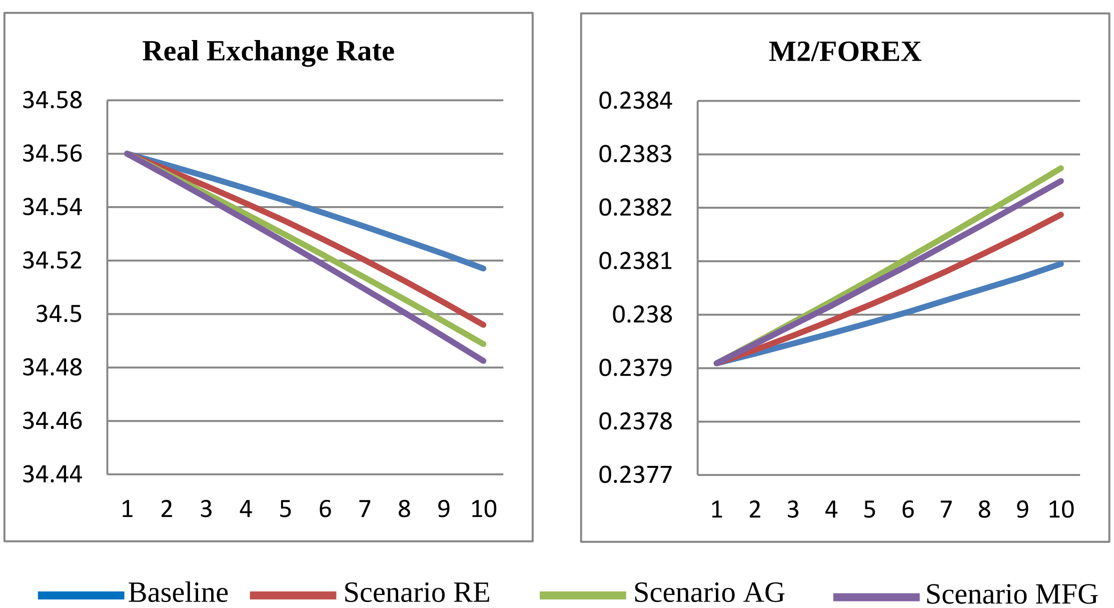

Figure 3.13: The indicators of vulnerability to crisis under the 5% investment increase annually in real estate, agriculture, and manufacturing sectors

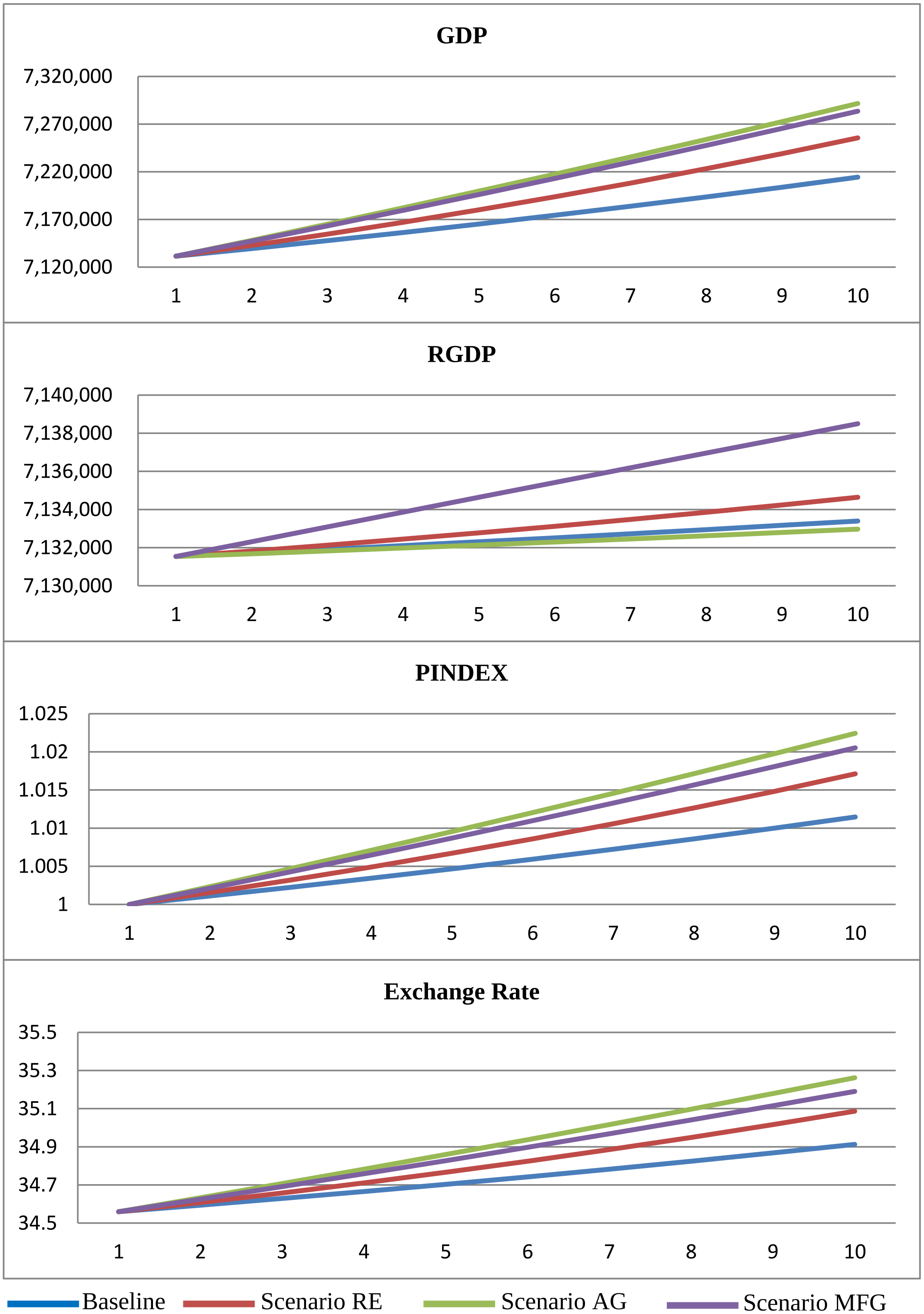

Figure 3.14: The macroeconomic indicators of the 5% investment increase annually in real estate, agriculture, and manufacturing sectors

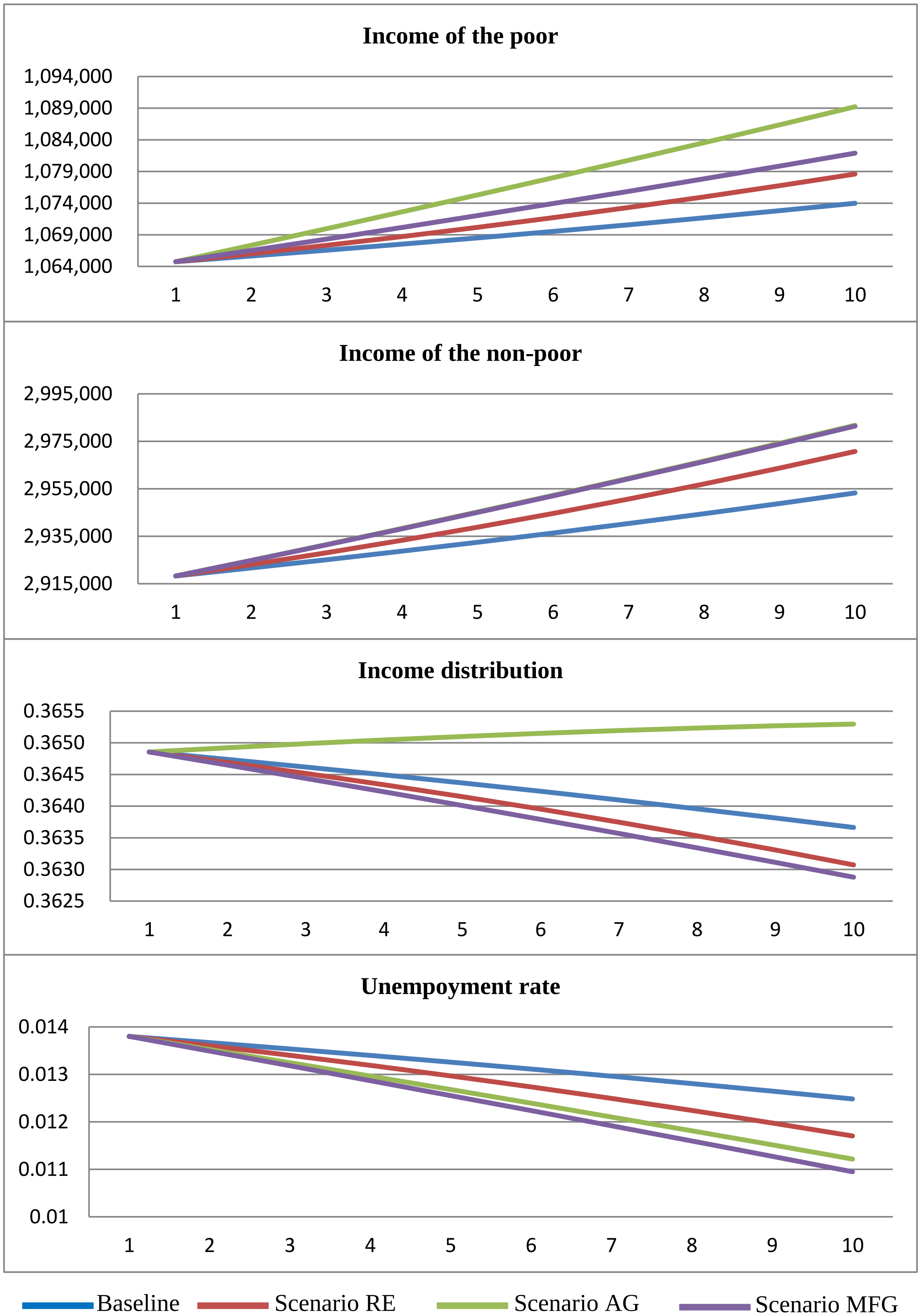

Figure 3.15: The socioeconomic indicators of the 5% investment increase annually in real estate, agriculture, and manufacturing sectors

3.5.2 Policy Implication

The simulation of three scenarios of a 5 percent increase in investment in real estate, agriculture, and manufacturing sectors illustrates both the risks and opportunities from such investment scenarios. Table 3.3 summarizes the simulation results of various indicators at the end of year 10. As can be seen, in comparison to the baseline, there is a marginal difference in terms of vulnerability to crisis among three scenarios.

The results suggest that, although the investment in agriculture sector may lead to high growth in term of GDP, it also contributes to higher inflation, resulting in lower GDP growth in real term. In addition, the investment in manufacturing may yield to the highest RGDP growth and lowest unemployment rate, but it worsens income distribution between the poor and non-poor households. Although, 5 percent additional investment in the real estate sector, on the other, may not lead to high growth as much as in agriculture or manufacturing sectors, it seems to bring lower economic cost—in term of inflation—as well as lower social cost—in term of income distribution—to the Thai economy. Investment in the real estate sector contributes the least impact on increasing average commodity price.

The simulation demonstrates that moderate investment in the real estate sector does not strongly cause the country to be vulnerable to financial crisis. Such investment may also benefit the Thai economy economically and socially. Therefore, monitoring mechanisms to control overheating or speculative investment in real estate are recommended. Such policies may include introducing a capital gains tax on real estate asset investment or an excise tax on real estate properties. These tax mechanisms are currently not imposed in Thailand, yet they could be elements of a policy that controls overheating or unsound real estate investment.

Table 3.3: The results of 5% investment increase on real estate, agriculture, and manufacturing sectors at the end of year 10

Variables	Baseline	Real estate	Agriculture	Manufacturing
Vulnerability to crisis				
M2/FOREX	0.23810	0.23819	0.23827	0.23825
RER	34.5170	34.496	34.489	34.482
Macroeconomic indicators				
GDP	7,214,334	7,255,572	7,291,635	7,283,635
RGDP	7,133,400	7,134,646	7,132,971	7,138,499
PINDEX	1.012	1.017	1.022	1.021
EXR	34.913	35.086	35.262	35.191
Socioeconomic indicators				
Income of the poor	1,073,982	1,078,600	1,089,227	1,081,892
Income of the non-poor	2,953,232	2,970,756	2,981,759	2,981,416
Income distribution	0.3637	0.3631	0.3653	0.3629
Unemployment rate	0.0125	0.0117	0.0112	0.0109

3.6 Conclusion

Growth in the economy of Thailand is highly related with the role of the real estate industry. While the framework of SAM and CGE show the interaction between real estate and other sectors in the real economy, the flow of funds accounts and FSAM extend the more realistic picture of connection between real estate and the financial market. With the FCGE model, the simulations of the role of real estate industry on economy and social welfare can be investigated. The simulation has shown that opportunities and risks from higher investment in real estate are not as high as higher investment in agriculture and manufacturing sectors.

In addition, various policy implications can be applied to mitigate the negative effects from the real estate investment in Thailand. The analysis suggests that moderate growth in the real estate sector is desirable. Thus, taxation policies, such as a capital gains tax on investment in real estate assets and an excise tax on real estate properties, should be implemented to control overheating real estate investment. Upon the availability of greater detail FSAM and data on asset and liability holdings of institutions beside households such as government and financial instructions, this FCGE model can be extended to incorporate asset holding behaviors of such institutions.

APPENDIX 3.1

Description of 71 sectors in 2007 FSAM of Thailand

Factor of production

FACT1	Non-agricultural Labor
FACT2	Agricultural Labor
FACT3	Capital

Production sectors

SEC1	Agriculture
SEC2	Fishery
SEC3	Mining and Quarrying
SEC4	Manufacturing
SEC5	Electricity and Water Supply
SEC6	Construction
SEC7	Wholesale and Retail Trade
SEC8	Hotel & Restaurant
SEC9	Transportation and Communication
SEC10	Financial Intermediation
SEC11	Real Estate and Renting
SEC12	Public Administration and Defence
SEC13	Education
SEC14	Health
SEC15	Other Services
TTM	Trade & Transport Margins
ITAX	Indirect Tax
SUBY	Subsidy

Institutions

HHH1	Household 1
HHH2	Household 2
HHH3	Household 3
HHH4	Household 4
HHH5	Household 5
GOV	Government
POE	Private Companies
SOE	State-owned Enterprises
FIN	Financial Institutions
ROW	Rest of the World

Capital accounts

KHHH1	Capital Account of Household 1
KHHH2	Capital Account of Household 2
KHHH3	Capital Account of Household 3
KHHH4	Capital Account of Household 4
KHHH5	Capital Account of Household 5
KGOV	Capital Account of Government
KPOE	Capital Account of Private Companies
KSOE	Capital Account of State-owned Enterprises
KFIN	Capital Account of Financial Institutions
KROW	Capital Account of Rest of the World

Financial instruments

FINA1	Cash
FINA2	Deposits
FINA3	Loans & Bills
FINA4	BoT, FIDF, Gov Bonds & T-Bill
FINA5	SoE & Corp Bonds
FINA6	Equity - Listed
FINA7	Foreign Asset/Liab
FINA8	Equity - Non-listed
FINA9	Other items
FINA10	FOREX Reserve

APPENDIX 3.2

Price block

$$PM_{im} = PWM_{im} * EXR_r * (1 + tm_{im} + ttf_{im} - psubm_{im}) \quad \text{(A1)}$$

$$PE_{ie} = \frac{(PWE_{ie} * EXR)}{(1 - psube_{ie})} \quad \text{(A2)}$$

$$PQ_i * Q_i = PD_i * D_i + PM_i * M_i \quad \text{(A3)}$$

$$PX_i * X_i = (1 - tdom_i - ttd_i - impf_i) * PD_i * D_i + PE_i * E_i + SUB_i \quad \text{(A4)}$$

$$PV_i * VA_i = (PX_i * X_i) - (PINTM_i * INTM_i) \quad \text{(A5)}$$

$$PINTM_i * INTM_i = (PDINTM_i * DINTM_i) + (PFINTM_i * FINTM_i) \quad \text{(A6)}$$

$$PDINTM_i = \sum_j (aad_{j,i} * PQ_j) \quad \text{(A7)}$$

$$PFINTM_i = \sum_j (aaf_{j,i} * PQ_j) \quad \text{(A8)}$$

$$PK_i = \sum_j (PQ_j * capmat_{j,i}) \quad \text{(A9)}$$

$$PINDEX = \sum_i (wtq_i * PQ_i) \quad \text{(A10)}$$

$$wtq_i = \frac{Q_i}{\sum_j Q_j} \quad \text{(A11)}$$

Distortion block

$$DTTM_i = ttd_i * PD_i * D_i \quad \text{(A12)}$$

$$FTTM_i = ttf_i * PWM_i * EXR * M_i \quad \text{(A13)}$$

$$INDTAX_i = tdom_i * PD_i * D_i \quad \text{(A14)}$$

$$TARIFF_i = tm_i * PWM_i * EXR * M_i \quad \text{(A15)}$$

$$IMPERFECT_i = impf_i * PD_i * D_i \quad \text{(A16)}$$

$$SUBE_i = psube_i * PE_i * E_i \quad \text{(A17)}$$

$$SUBM_i = psubm_i * PWM_i * EXR * M_i \tag{A18}$$

Production block

$$X_i = ai_i * (bi_i * VA_i^{-rhoi_i} + (1 - bi_i) * INTM_i^{-rhoi_i})^{-1/rhoi_i} \tag{A19}$$

$$INTM_i = VA_i * (\frac{PV_i}{PINTM_i} * \frac{(1-bi_i)}{bi_i})^{1/(1+rhoi_i)} \tag{A20}$$

$$VA_i = avx_i * av_i * (\sum_f bv_{i,f} * FACDEM_{i,f}^{-rhov_i})^{-1/rhov_i} \tag{A21}$$

$$FACDEM_{i,f} = VA_i * (\frac{bv_{i,f} * PV_i}{WF_f * WFDIST_{i,f} * (avx_i * av_i)^{rhov_i}})^{1/(1+rhov_i)} \tag{A22}$$

$$WAGES_i = PINDEX^{vp_i} * (\frac{PV_i}{PV0_i})^{(1-vp_i)} * (\frac{\frac{X_i}{\sum_{fl} FACDEM_{i,fl}}}{PDL0_i})^{phi_i} \tag{A23}$$

$$WF_{fl} = WF0_{fl} * \sum_i (WAGES_i * wlshare_{i,fl}) \tag{A24}$$

$$INTM_i = at_i * \left(bt_i * DINTM_i^{-rhot_i} + (1 - bt_i) * FINTM_i^{-rhot_i}\right)^{-\frac{1}{rhot_i}}, \tag{A25}$$

$$for\ FDINTM0_i > 0\ and\ DINTM_i > 0$$

$$INTM_i = DINTM_i\ , for\ FDINTM0_i = 0 \tag{A26}$$

$$INTM_i = FINTM_i\ , for\ DINTM_i = 0 \tag{A27}$$

$$FINTM_i = DINTM_i * \left(\frac{PDINTM_i}{PFINTM_i} * \frac{(1-bi_i)}{bi_i}\right)^{1/(1+rhoi_i)} \tag{A28}$$

$$for\ FDINTM0_i > 0\ and\ DINTM_i > 0$$

$$FINTM_i = 0\ , for\ FINTM0_i = 0 \tag{A29}$$

$$DINTM_i = 0\ , for\ DINTM0_i = 0 \tag{A30}$$

$$Q_{im} = aq_{im} * (bq_{im} * D_{im}^{-rhoq_{im}} + (1 - bq_{im}) * M_{im}^{-rhoq_{im}})^{-1/rhoq_{im}} \tag{A31}$$

$$Q_{im} = D_{im}\ , for\ M0_i = 0 \tag{A32}$$

$$M_{im} = D_{im} * \left(\frac{PD_{im}}{PM_{im}} * \frac{(1-bq_{im})}{bq_{im}}\right)^{1/(1+rhoq_{im})} \tag{A33}$$

$$X_{ie} = ax_{ie} * (bx_{ie} * D_{ie}^{-rhox_{ie}} + (1 - bx_{ie}) * E_{ie}^{-rhox_i})^{1/rhox_{ie}} \tag{A34}$$

$$X_{ie} = D_{ie}\ , for\ E0_i = 0 \tag{A35}$$

$$E_{ie} = D_{ie} * \left(\left(\frac{PE_{ie}}{(1 - tdom_{ie} - ttd_{ie} - imf_{ie}) * PD_{ie}}\right) * \left(\frac{bx_{ie}}{1 - bx_{ie}}\right)\right)^{1/(rhox_{ie}-1)} \tag{A36}$$

$$INTQ_i = \sum_j (aad_{i,j} * DINTM_j + aaf_{i,j} * FINTM_j) \tag{A37}$$

$$TTM_i = DTTM_i + FTTM_i \tag{A38}$$

$$TTMX_i = ttx_i * \sum_j TTM_j \tag{A39}$$

$$DIRTAX_{gin,din} = dtax_{gin,din} * INC_{din} \tag{A40}$$

Income block

$$YF_f = \sum_i (WF_f * WFDIST_{i,f} * FACDEM_{i,f}) + \sum_{fr} YFROW_{f,fr} \tag{A41}$$

$$INC_{ngi} = \sum_f (factoin_{ngi,f} * YF_f) + \sum_{in2} ITRAN_{ngi,in2} \tag{A42}$$

$$INC_{gin} = \sum_f (factoin_{gin,f} * YF_f) + \sum_{in2} \left(ITRAN_{gin,in2}\right) + gishr_{gin} * \sum_i (INDTAX_i + TARIFF_i) \tag{A43}$$

$$INC_{fr} = \sum_f (factoin_{fr,f} * YF_f) + \sum_{in2} \left(ITRAN_{fr,in2}\right) + mrshr_{fr} * \sum_i (PWM_i * EXR_r * M_i) \tag{A44}$$

Transfer block

$$ITRAN_{in,in2} = GTRAN_{in,in2} + RTRAN_{in,in2} + OTRAN_{in,in2} \tag{A45}$$

$$GTRAN_{gin,din} = DIRTAX_{gin,din} \tag{A46}$$

$$RTRAN_{h,in2} = RNshare_h * \sum_{asrn} (RN_{asrn} * LiabSLag_{in2,asrn}) \tag{A47}$$

$$RTRAN_{h,in2} = 0\ , for\ RTRAN0_{h,in2} = 0 \tag{A48}$$

$$RNshare_{in} = \frac{\sum_{asrn} (RN_{asrn} * AssetSLag_{asrn,in})}{\sum_{asrn} \sum_{in2} (RN_{asrn} * AssetSLag_{asrn,in2})} \tag{A49}$$

Expenditure block

$$YCONS_h = \left(INC_h - \sum_{gin}\left(DIRTAX_{gin,h}\right) * (1 - mps_h)\right) - \sum_{ngi} ITRAN_{ngi,h} - \sum_{fr} ITRAN_{fr,h} \quad \text{(A50)}$$

$$EXP_h = YCONS_h + \sum_{gin} DIRTAX_{gin,h} + \sum_{ngi} ITRAN_{ngi,h} + \sum_{fr} ITRAN_{fr,h} \quad \text{(A51)}$$

$$EXP_{gin} = ggshr_{gin} * \sum_i (PQ_i * GD_i) + \sum_{in} ITRAN_{in,gin} + \sum_i (SUB_i + SUBE_i + SUBM_i) \quad \text{(A52)}$$

$$EXP_{nno} = \sum_{in} ITRAN_{in,nno} \quad \text{(A53)}$$

$$EXP_{fr} = ershr_{fr} * \sum_i (PWR_i * EXP * E_i) + \sum_f YFROW_{f,fr} + \sum_{in} ITRAN_{in,fr} \quad \text{(A54)}$$

$$SAV_{din} = INC_{din} - EXP_{din} \quad \text{(A55)}$$

$$SAV_{fr} = INC_{fr} - EXP_{fr} \quad \text{(A56)}$$

$$SAV_{fr} = EXR * FSAV_{fr} \quad \text{(A57)}$$

$$SAVING = \sum_{in} SAV_{in} \quad \text{(A58)}$$

$$MPS_h = MPS0_h + mpsq_h * |MPS0_h| * \left(\frac{INC_h - INC0_h}{INC0_h}\right) \quad \text{(A59)}$$

Expenditure block

$$CD_i = \frac{\sum_h (alphaq_{i,h} * YCON_h)}{PQ_i} \quad \text{(A60)}$$

$$PK_i * DK_i = KSHR_i * INVEST \quad \text{(A61)}$$

$$ID_i = \sum_{in} \frac{INVES_{i,in}}{PQ_i} \quad \text{(A62)}$$

$$INVEST = \sum_i \sum_{in} INVES_{i,in} \quad \text{(A63)}$$

$$INVES_{i,pin} = lambda0_{i,pin} * VA_i^{lambda1_i} * (1 + avgRN)^{lambda2_i} * EXR^{lambda3_i}$$

$$+ parad_{i,pin} * pinve_{i,pin} * fixin_{pin}$$

$$* \sum_{aseq} \sum_{fr} (Asset_{aseq,fr} - Asset0_{aseq,fr})$$

$$+ parae_{i,pin} * pinve_{i,pin} * fixin_{pin}$$

$$* \sum_{fr} \sum_{aseq} (Asset_{FINA3,fr} - Asset0_{FINA3,fr}) \quad \text{(A64)}$$

$$INVES_{i,fr} = EXR * FINVES_{i,fr} \quad \text{(A65)}$$

$$avgRN = \frac{\sum_{as} \sum_{in} (RN_{as} * AssetSLag_{as,in})}{\sum_{as} \sum_{in} AssetSLag_{as,in}} \quad \text{(A66)}$$

$$avx_i = \left(\frac{\sum_{fr} FINVES_{i,fr}}{\sum_{fr} FINVES0_{i,fr}}\right)^{avxq_i} \quad \text{(A67)}$$

Market clearing

$$Q_i = INTQ_i + CD_i + GD_i + ID_i + \frac{TTMX_i}{PQ_i} \quad \text{(A68)}$$

$$FS_f = \sum_i FACDEM_{i,f} \quad \text{(A69)}$$

$$LSUP = (1 + UEMPR) * \sum_{fl} FS_{fl} \quad \text{(A70)}$$

Gross National Product & Utility

$$GDP = \sum_i (PV_i * VA_i + INDTAX_i + TARIFF_i - SUB_i - SUBM_i) \quad \text{(A71)}$$

$$RGDP = \sum_i (CD_i + ID_i + GD_i + \sum_i E_i - \sum_i (1 - TMREAL0_i) * M_i) \quad \text{(A72)}$$

Financial balance

$$AssetS_{as,in} = AssetSLag_{as,in} + Asset_{as,in} \quad \text{(B1)}$$

$$LiabS_{in,as} = LiabSLag_{in,as} + Liab_{in,as} \quad \text{(B2)}$$

$$FixAS_{in} = FixASLag_{in} + FixA_{in} \quad \text{(B3)}$$

$$Wealth_{in} = WealthLag_{in} + WEALF_{in} \tag{B4}$$

$$FixA_{in} = \sum_{rr} INVES_{i,in} \tag{B5}$$

$$WEALF_{in} = SAV_{in} \tag{B6}$$

Composite interest rate

$$rna1_{in} = \frac{\sum_{asdp}(rn_{asdp} * AssetSLag_{asdp,in})}{\sum_{asdp} AssetSLag_{asdp,in}} \tag{B7}$$

$$rna2_{in} = \frac{\sum_{asgb}(rn_{asgb} * AssetSLag_{asgb,in})}{\sum_{asgb} AssetSLag_{asgb,in}} \tag{B8}$$

$$rna3_{in} = \frac{\sum_{aseq}(rn_{aseq} * AssetSLag_{aseq,in})}{\sum_{aseq} AssetSLag_{aseq,in}} \tag{B9}$$

$$rna4_{in} = \frac{\sum_{ascr}(rn_{ascr} * AssetSLag_{ascr,in})}{\sum_{ascr} AssetSLag_{ascr,in}} \tag{B10}$$

$$rna5_{in} = \frac{\sum_{asot}(rn_{asot} * AssetSLag_{asot,in})}{\sum_{asot} AssetSLag_{asot,in}} \tag{B11}$$

Foreign reserve

$$AssetS_{asfxr,SOE1} = LiabS_{ROW,asfxr} \tag{B12}$$

Currency & demand deposit

$$MD_{in} = alpha1_{in} + INC_{in}{}^{alpha2_{in}} * rnv_{in}{}^{-alpha3_{in}} \tag{B12}$$

$$rnv1_{in} = \frac{\sum_{nasmd}(rn_{nasmd} * AssetSLag_{nasmd,in})}{\sum_{nasmd} AssetSLag_{nasmd,in}} \tag{B13}$$

$$AssetS_{asmd,in} = mdshare_{asmd,in} * MD_{in} \tag{B14}$$

$$LiabS_{in,asmd} = mdshr_{in,asmd} * \sum_{in2} AssetS_{asmd,in2} \tag{B15}$$

Equation: Asset ==> Liab

$$AssetS_{ast1,in} = theta1_{ast1,in} * \left(\frac{rn_{ast1}}{rn0_{ast1}}\right)^{sigma1_{ast1,in}} \tag{B15}$$

$$LiabS_{in,ast1} = ast1shr_{in,ast1} * \sum_{in2} AssetS_{ast1,in2} \tag{B16}$$

Equation: Asset <== Liab

$$LiabS_{in,ast20} = theta2_{in,ast20} * \left(\frac{rn_{ast20}}{rn0_{ast20}}\right)^{sigma2_{in,ast20}} \tag{B17}$$

$$AssetS_{ast2,in} = ast2shr_{ast2,in} * \sum_{in2} LiabS_{in2,ast2} \tag{B18}$$

Equation: Asset === Liab

$$AssetS_{aste,in} = asteshr_{aste,in} * \sum_{in2} LiabS_{in2,ast2} \tag{B19}$$

$$LiabS_{GOV1,aste} = theta2_{GOV1,aste} * \left(\frac{rn_{aste}}{rn0_{aste}}\right)^{sigma2_{GOV1,aste}} \tag{B20}$$

Institutional balance

$$\sum_{as} AssetS_{as,in} + FixAS_{in} = \sum_{as} LiabS_{in,as} + Wealth_{in} \tag{B21}$$

Equity market

$$AssetS_{aste,in} = PEQ_{aste} * EQAssetS_{aste,in} \tag{C1}$$

$$LiabS_{in,aseq} = PEQ_{aseq} * EQLiabS_{in,aseq} \tag{C2}$$

$$EQLiabS_{in,aseq} = aseqshr_{in,aste} * \sum_{in2} EQAssetS_{aste,in} \tag{C3}$$

$$PEQ_{aste} = \frac{\sum_{in2} EQAssetS_{aste,in}}{\sum_{in2} EQAssetS_{aste,in}{}^{qeq_{aseq}}} \tag{C4}$$

Asset allocation

$$\frac{gh1}{1-gh1} = phih1 * \left(\frac{1+avgRNmd}{1+avgRNnmd}\right)^{epsh1} \qquad \text{(C5)}$$

$$\sum_{hhr} MD_{hhr} + \sum_{asdp} AssetS_{asdp,hhr} = gh1 * \sum_{as,hhr} AssetS_{as,hhr} \qquad \text{(C6)}$$

$$\sum_{asnmd,hhr} RN_{asnmd} * AssetS_{asmd,hhr} = (1 - gh1) * \sum_{as,hhr} AssetS_{as,hhr} \qquad \text{(C7)}$$

Equations of the relationship of property and asset markets

$$restock = REcons + (coeff1 * RGDP) + (coeff2 * PQ_{SEC11})$$

$$+(coeff3 * avgRN) \qquad \text{(C8)}$$

$$PAsset = \frac{avgRN}{RNRE} \qquad \text{(C9)}$$

$$replace = \frac{PAsset}{PQ_{SEC6}} \qquad \text{(C10)}$$

$$restock = (PQ_{SEC6} * Q_{SEC6}) - (redep * Q_{SEC11}) \qquad \text{(C11)}$$

APPENDIX 3.3

Financial Social Accounting Matrix of Thailand in 2007

Sector	FACT1	FACT2	FACT3	SEC1	SEC2	SEC3	SEC4	SEC5	SEC6
FACT1	0	0	0	0	0	18728	785289	45337	68773
FACT2	0	0	0	173025	34462	0	0	0	0
FACT3	0	0	0	310674	85369	101319	1375185	163214	138582
SEC1	0	0	0	0	0	0	0	0	0
SEC2	0	0	0	0	0	0	0	0	0
SEC3	0	0	0	0	0	0	0	0	0
SEC4	0	0	0	0	0	0	0	0	0
SEC5	0	0	0	0	0	0	0	0	0
SEC6	0	0	0	0	0	0	0	0	0
SEC7	0	0	0	0	0	0	0	0	0
SEC8	0	0	0	0	0	0	0	0	0
SEC9	0	0	0	0	0	0	0	0	0
SEC10	0	0	0	0	0	0	0	0	0
SEC11	0	0	0	0	0	0	0	0	0
SEC12	0	0	0	0	0	0	0	0	0
SEC13	0	0	0	0	0	0	0	0	0
SEC14	0	0	0	0	0	0	0	0	0
SEC15	0	0	0	0	0	0	0	0	0
COMD1	0	0	0	39360	3	0	422079	0	4
COMD2	0	0	0	2350	53242	0	82722	0	0
COMD3	0	0	0	6	0	1635	583563	64503	13105
COMD4	0	0	0	133160	27063	242	3833746	72245	259688
COMD5	0	0	0	2494	73	65	192867	74645	160
COMD6	0	0	0	166	6	24	204432	1065	10662
COMD7	0	0	0	42007	10182	76	621826	2934	65496
COMD8	0	0	0	22173	1	69	12099	261	1828
COMD9	0	0	0	14022	1774	364	194199	1951	129611
COMD10	0	0	0	3220	12	159	171060	1047	995
COMD11	0	0	0	12790	0	27	7220	35	86
COMD12	0	0	0	0	0	0	0	0	0
COMD13	0	0	0	0	0	0	1437	272	21
COMD14	0	0	0	0	0	0	0	0	0
COMD15	0	0	0	7	2	40	104560	324	8226
COMF1	0	0	0	92534	0	0	0	0	0
COMF2	0	0	0	0	1900	0	0	0	0
COMF3	0	0	0	0	0	565670	0	0	0
COMF4	0	0	0	0	0	0	3985006	0	0
COMF5	0	0	0	0	0	0	0	55946	0
COMF6	0	0	0	0	0	0	0	0	12815
COMF7	0	0	0	0	0	0	0	0	0
COMF8	0	0	0	0	0	0	0	0	0
COMF9	0	0	0	0	0	0	0	0	0
COMF10	0	0	0	0	0	0	0	0	0
COMF11	0	0	0	0	0	0	0	0	0
COMF12	0	0	0	0	0	0	0	0	0
COMF13	0	0	0	0	0	0	0	0	0
COMF14	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	FACT1	FACT2	FACT3	SEC1	SEC2	SEC3	SEC4	SEC5	SEC6
COMF15	0	0	0	0	0	0	0	0	0
TTM1	0	0	0	0	0	0	0	0	0
ITAX1	0	0	0	0	0	0	0	0	0
SUBY1	0	0	0	0	0	0	0	0	0
HHH1	514	64321	71690	0	0	0	0	0	0
HHH2	79087	60171	139000	0	0	0	0	0	0
HHH3	207320	41498	203771	0	0	0	0	0	0
HHH4	405866	31123	364975	0	0	0	0	0	0
HHH5	1413494	10374	919151	0	0	0	0	0	0
GOV1	0	0	68676	0	0	0	0	0	0
POE1	0	0	0	0	0	0	0	0	0
SOE1	0	0	2238302	0	0	0	0	0	0
FIN1	0	0	0	0	0	0	0	0	0
ROW1	0	0	0	0	0	0	0	0	0
KHHH1	0	0	0	0	0	0	0	0	0
KHHH2	0	0	0	0	0	0	0	0	0
KHHH3	0	0	0	0	0	0	0	0	0
KHHH4	0	0	0	0	0	0	0	0	0
KHHH5	0	0	0	0	0	0	0	0	0
KGOV1	0	0	0	0	0	0	0	0	0
KPOE1	0	0	0	0	0	0	0	0	0
KSOE1	0	0	0	0	0	0	0	0	0
KFIN1	0	0	0	0	0	0	0	0	0
KROW1	0	0	0	0	0	0	0	0	0
FINA1	0	0	0	0	0	0	0	0	0
FINA2	0	0	0	0	0	0	0	0	0
FINA3	0	0	0	0	0	0	0	0	0
FINA4	0	0	0	0	0	0	0	0	0
FINA5	0	0	0	0	0	0	0	0	0
FINA6	0	0	0	0	0	0	0	0	0
FINA7	0	0	0	0	0	0	0	0	0
FINA8	0	0	0	0	0	0	0	0	0
FINA9	0	0	0	0	0	0	0	0	0
FINA10	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	SEC7	SEC8	SEC9	SEC10	SEC11	SEC12	SEC13	SEC14	SEC15
FACT1	398535	112187	142360	67706	14011	196256	124278	46813	86007
FACT2	0	0	0	0	0	0	0	0	0
FACT3	521061	209830	364456	158259	192543	94557	156397	78450	55669
SEC1	0	0	0	0	0	0	0	0	0
SEC2	0	0	0	0	0	0	0	0	0
SEC3	0	0	0	0	0	0	0	0	0
SEC4	0	0	0	0	0	0	0	0	0
SEC5	0	0	0	0	0	0	0	0	0
SEC6	0	0	0	0	0	0	0	0	0
SEC7	0	0	0	0	0	0	0	0	0
SEC8	0	0	0	0	0	0	0	0	0
SEC9	0	0	0	0	0	0	0	0	0
SEC10	0	0	0	0	0	0	0	0	0
SEC11	0	0	0	0	0	0	0	0	0
SEC12	0	0	0	0	0	0	0	0	0
SEC13	0	0	0	0	0	0	0	0	0
SEC14	0	0	0	0	0	0	0	0	0
SEC15	0	0	0	0	0	0	0	0	0
COMD1	1	76362	33	7	26	0	60	4	14
COMD2	0	13321	20	0	0	0	709	15	5
COMD3	152	1527	730	318	54	0	0	0	82
COMD4	120089	315000	411665	6872	3609	0	17698	34118	103511
COMD5	70379	11710	12136	4817	11847	0	7010	79	250
COMD6	7086	8463	6027	208	648	0	1659	284	3
COMD7	1852101	80067	44005	6217	519	0	5611	19626	22784
COMD8	436690	1369	37479	16255	3447	0	10073	46	417
COMD9	158819	16724	470764	12221	1517	0	5117	1815	2796
COMD10	9148	5968	30691	7244	8964	0	2768	194	10
COMD11	44102	1276	8759	7622	2721	0	258	2	126
COMD12	0	0	0	0	0	0	0	0	0
COMD13	0	0	682	6633	498	0	1742	78	208
COMD14	0	0	0	0	0	0	0	49892	0
COMD15	18142	6945	16133	2103	1425	0	977	3198	43
COMF1	0	0	0	0	0	0	0	0	0
COMF2	0	0	0	0	0	0	0	0	0
COMF3	0	0	0	0	0	0	0	0	0
COMF4	0	0	0	0	0	0	0	0	0
COMF5	0	0	0	0	0	0	0	0	0
COMF6	0	0	0	0	0	0	0	0	0
COMF7	15807	0	0	0	0	0	0	0	0
COMF8	0	3090	0	0	0	0	0	0	0
COMF9	0	0	134026	0	0	0	0	0	0
COMF10	0	0	0	18994	0	0	0	0	0
COMF11	0	0	0	0	484	0	0	0	0
COMF12	0	0	0	0	0	16112	0	0	0
COMF13	0	0	0	0	0	0	66	0	0
COMF14	0	0	0	0	0	0	0	284	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	SEC7	SEC8	SEC9	SEC10	SEC11	SEC12	SEC13	SEC14	SEC15
COMF15	0	0	0	0	0	0	0	0	215253
TTM1	0	0	0	0	0	0	0	0	0
ITAX1	0	0	0	0	0	0	0	0	0
SUBY1	0	0	0	0	0	0	0	0	0
HHH1	0	0	0	0	0	0	0	0	0
HHH2	0	0	0	0	0	0	0	0	0
HHH3	0	0	0	0	0	0	0	0	0
HHH4	0	0	0	0	0	0	0	0	0
HHH5	0	0	0	0	0	0	0	0	0
GOV1	0	0	0	0	0	0	0	0	0
POE1	0	0	0	0	0	0	0	0	0
SOE1	0	0	0	0	0	0	0	0	0
FIN1	0	0	0	0	0	0	0	0	0
ROW1	0	0	0	0	0	0	0	0	0
KHHH1	0	0	0	0	0	0	0	0	0
KHHH2	0	0	0	0	0	0	0	0	0
KHHH3	0	0	0	0	0	0	0	0	0
KHHH4	0	0	0	0	0	0	0	0	0
KHHH5	0	0	0	0	0	0	0	0	0
KGOV1	0	0	0	0	0	0	0	0	0
KPOE1	0	0	0	0	0	0	0	0	0
KSOE1	0	0	0	0	0	0	0	0	0
KFIN1	0	0	0	0	0	0	0	0	0
KROW1	0	0	0	0	0	0	0	0	0
FINA1	0	0	0	0	0	0	0	0	0
FINA2	0	0	0	0	0	0	0	0	0
FINA3	0	0	0	0	0	0	0	0	0
FINA4	0	0	0	0	0	0	0	0	0
FINA5	0	0	0	0	0	0	0	0	0
FINA6	0	0	0	0	0	0	0	0	0
FINA7	0	0	0	0	0	0	0	0	0
FINA8	0	0	0	0	0	0	0	0	0
FINA9	0	0	0	0	0	0	0	0	0
FINA10	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	COMD1	COMD2	COMD3	COMD4	COMD5	COMD6	COMD7	COMD8	COMD9
FACT1	0	0	0	0	0	0	0	0	0
FACT2	0	0	0	0	0	0	0	0	0
FACT3	0	0	0	0	0	0	0	0	0
SEC1	847988	0	0	0	0	0	0	0	0
SEC2	0	214089	0	0	0	0	0	0	0
SEC3	0	0	688417	0	0	0	0	0	0
SEC4	0	0	0	12577292	0	0	0	0	0
SEC5	0	0	0	0	483780	0	0	0	0
SEC6	0	0	0	0	0	710051	0	0	0
SEC7	0	0	0	0	0	0	3652113	0	0
SEC8	0	0	0	0	0	0	0	863839	0
SEC9	0	0	0	0	0	0	0	0	1679967
SEC10	0	0	0	0	0	0	0	0	0
SEC11	0	0	0	0	0	0	0	0	0
SEC12	0	0	0	0	0	0	0	0	0
SEC13	0	0	0	0	0	0	0	0	0
SEC14	0	0	0	0	0	0	0	0	0
SEC15	0	0	0	0	0	0	0	0	0
COMD1	0	0	0	0	0	0	0	0	0
COMD2	0	0	0	0	0	0	0	0	0
COMD3	0	0	0	0	0	0	0	0	0
COMD4	0	0	0	0	0	0	0	0	0
COMD5	0	0	0	0	0	0	0	0	0
COMD6	0	0	0	0	0	0	0	0	0
COMD7	0	0	0	0	0	0	0	0	0
COMD8	0	0	0	0	0	0	0	0	0
COMD9	0	0	0	0	0	0	0	0	0
COMD10	0	0	0	0	0	0	0	0	0
COMD11	0	0	0	0	0	0	0	0	0
COMD12	0	0	0	0	0	0	0	0	0
COMD13	0	0	0	0	0	0	0	0	0
COMD14	0	0	0	0	0	0	0	0	0
COMD15	0	0	0	0	0	0	0	0	0
COMF1	0	0	0	0	0	0	0	0	0
COMF2	0	0	0	0	0	0	0	0	0
COMF3	0	0	0	0	0	0	0	0	0
COMF4	0	0	0	0	0	0	0	0	0
COMF5	0	0	0	0	0	0	0	0	0
COMF6	0	0	0	0	0	0	0	0	0
COMF7	0	0	0	0	0	0	0	0	0
COMF8	0	0	0	0	0	0	0	0	0
COMF9	0	0	0	0	0	0	0	0	0
COMF10	0	0	0	0	0	0	0	0	0
COMF11	0	0	0	0	0	0	0	0	0
COMF12	0	0	0	0	0	0	0	0	0
COMF13	0	0	0	0	0	0	0	0	0
COMF14	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	COMD1	COMD2	COMD3	COMD4	COMD5	COMD6	COMD7	COMD8	COMD9
COMF15	0	0	0	0	0	0	0	0	0
TTM1	0	0	0	0	0	0	0	0	0
ITAX1	1410	18	25067	535551	22851	8179	78314	43766	22625
SUBY1	0	0	0	0	0	0	0	0	0
HHH1	0	0	0	0	0	0	0	0	0
HHH2	0	0	0	0	0	0	0	0	0
HHH3	0	0	0	0	0	0	0	0	0
HHH4	0	0	0	0	0	0	0	0	0
HHH5	0	0	0	0	0	0	0	0	0
GOV1	0	0	0	0	0	0	0	0	0
POE1	0	0	0	0	0	0	0	0	0
SOE1	0	0	0	0	0	0	0	0	0
FIN1	0	0	0	0	0	0	0	0	0
ROW1	0	0	0	0	0	0	0	0	0
KHHH1	0	0	0	0	0	0	0	0	0
KHHH2	0	0	0	0	0	0	0	0	0
KHHH3	0	0	0	0	0	0	0	0	0
KHHH4	0	0	0	0	0	0	0	0	0
KHHH5	0	0	0	0	0	0	0	0	0
KGOV1	0	0	0	0	0	0	0	0	0
KPOE1	0	0	0	0	0	0	0	0	0
KSOE1	0	0	0	0	0	0	0	0	0
KFIN1	0	0	0	0	0	0	0	0	0
KROW1	0	0	0	0	0	0	0	0	0
FINA1	0	0	0	0	0	0	0	0	0
FINA2	0	0	0	0	0	0	0	0	0
FINA3	0	0	0	0	0	0	0	0	0
FINA4	0	0	0	0	0	0	0	0	0
FINA5	0	0	0	0	0	0	0	0	0
FINA6	0	0	0	0	0	0	0	0	0
FINA7	0	0	0	0	0	0	0	0	0
FINA8	0	0	0	0	0	0	0	0	0
FINA9	0	0	0	0	0	0	0	0	0
FINA10	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	COMD10	COMD11	COMD12	COMD13	COMD14	COMD15	COMF1	COMF2	COMF3
FACT1	0	0	0	0	0	0	0	0	0
FACT2	0	0	0	0	0	0	0	0	0
FACT3	0	0	0	0	0	0	0	0	0
SEC1	0	0	0	0	0	0	0	0	0
SEC2	0	0	0	0	0	0	0	0	0
SEC3	0	0	0	0	0	0	0	0	0
SEC4	0	0	0	0	0	0	0	0	0
SEC5	0	0	0	0	0	0	0	0	0
SEC6	0	0	0	0	0	0	0	0	0
SEC7	0	0	0	0	0	0	0	0	0
SEC8	0	0	0	0	0	0	0	0	0
SEC9	0	0	0	0	0	0	0	0	0
SEC10	315475	0	0	0	0	0	0	0	0
SEC11	0	242312	0	0	0	0	0	0	0
SEC12	0	0	306926	0	0	0	0	0	0
SEC13	0	0	0	334423	0	0	0	0	0
SEC14	0	0	0	0	234899	0	0	0	0
SEC15	0	0	0	0	0	487178	0	0	0
COMD1	0	0	0	0	0	0	0	0	0
COMD2	0	0	0	0	0	0	0	0	0
COMD3	0	0	0	0	0	0	0	0	0
COMD4	0	0	0	0	0	0	0	0	0
COMD5	0	0	0	0	0	0	0	0	0
COMD6	0	0	0	0	0	0	0	0	0
COMD7	0	0	0	0	0	0	0	0	0
COMD8	0	0	0	0	0	0	0	0	0
COMD9	0	0	0	0	0	0	0	0	0
COMD10	0	0	0	0	0	0	0	0	0
COMD11	0	0	0	0	0	0	0	0	0
COMD12	0	0	0	0	0	0	0	0	0
COMD13	0	0	0	0	0	0	0	0	0
COMD14	0	0	0	0	0	0	0	0	0
COMD15	0	0	0	0	0	0	0	0	0
COMF1	0	0	0	0	0	0	0	0	0
COMF2	0	0	0	0	0	0	0	0	0
COMF3	0	0	0	0	0	0	0	0	0
COMF4	0	0	0	0	0	0	0	0	0
COMF5	0	0	0	0	0	0	0	0	0
COMF6	0	0	0	0	0	0	0	0	0
COMF7	0	0	0	0	0	0	0	0	0
COMF8	0	0	0	0	0	0	0	0	0
COMF9	0	0	0	0	0	0	0	0	0
COMF10	0	0	0	0	0	0	0	0	0
COMF11	0	0	0	0	0	0	0	0	0
COMF12	0	0	0	0	0	0	0	0	0
COMF13	0	0	0	0	0	0	0	0	0
COMF14	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	COMD10	COMD11	COMD12	COMD13	COMD14	COMD15	COMF1	COMF2	COMF3
COMF15	0	0	0	0	0	0	0	0	0
TTM1	0	0	0	0	0	0	0	0	0
ITAX1	29532	27070	0	-8099	2088	23830	0	0	0
SUBY1	0	0	0	0	0	0	0	0	0
HHH1	0	0	0	0	0	0	0	0	0
HHH2	0	0	0	0	0	0	0	0	0
HHH3	0	0	0	0	0	0	0	0	0
HHH4	0	0	0	0	0	0	0	0	0
HHH5	0	0	0	0	0	0	0	0	0
GOV1	0	0	0	0	0	0	0	0	0
POE1	0	0	0	0	0	0	0	0	0
SOE1	0	0	0	0	0	0	0	0	0
FIN1	0	0	0	0	0	0	0	0	0
ROW1	0	0	0	0	0	0	92534	1900	565670
KHHH1	0	0	0	0	0	0	0	0	0
KHHH2	0	0	0	0	0	0	0	0	0
KHHH3	0	0	0	0	0	0	0	0	0
KHHH4	0	0	0	0	0	0	0	0	0
KHHH5	0	0	0	0	0	0	0	0	0
KGOV1	0	0	0	0	0	0	0	0	0
KPOE1	0	0	0	0	0	0	0	0	0
KSOE1	0	0	0	0	0	0	0	0	0
KFIN1	0	0	0	0	0	0	0	0	0
KROW1	0	0	0	0	0	0	0	0	0
FINA1	0	0	0	0	0	0	0	0	0
FINA2	0	0	0	0	0	0	0	0	0
FINA3	0	0	0	0	0	0	0	0	0
FINA4	0	0	0	0	0	0	0	0	0
FINA5	0	0	0	0	0	0	0	0	0
FINA6	0	0	0	0	0	0	0	0	0
FINA7	0	0	0	0	0	0	0	0	0
FINA8	0	0	0	0	0	0	0	0	0
FINA9	0	0	0	0	0	0	0	0	0
FINA10	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	COMF4	COMF5	COMF6	COMF7	COMF8	COMF9	COMF10	COMF11	COMF12
FACT1	0	0	0	0	0	0	0	0	0
FACT2	0	0	0	0	0	0	0	0	0
FACT3	0	0	0	0	0	0	0	0	0
SEC1	0	0	0	0	0	0	0	0	0
SEC2	0	0	0	0	0	0	0	0	0
SEC3	0	0	0	0	0	0	0	0	0
SEC4	0	0	0	0	0	0	0	0	0
SEC5	0	0	0	0	0	0	0	0	0
SEC6	0	0	0	0	0	0	0	0	0
SEC7	0	0	0	0	0	0	0	0	0
SEC8	0	0	0	0	0	0	0	0	0
SEC9	0	0	0	0	0	0	0	0	0
SEC10	0	0	0	0	0	0	0	0	0
SEC11	0	0	0	0	0	0	0	0	0
SEC12	0	0	0	0	0	0	0	0	0
SEC13	0	0	0	0	0	0	0	0	0
SEC14	0	0	0	0	0	0	0	0	0
SEC15	0	0	0	0	0	0	0	0	0
COMD1	0	0	0	0	0	0	0	0	0
COMD2	0	0	0	0	0	0	0	0	0
COMD3	0	0	0	0	0	0	0	0	0
COMD4	0	0	0	0	0	0	0	0	0
COMD5	0	0	0	0	0	0	0	0	0
COMD6	0	0	0	0	0	0	0	0	0
COMD7	0	0	0	0	0	0	0	0	0
COMD8	0	0	0	0	0	0	0	0	0
COMD9	0	0	0	0	0	0	0	0	0
COMD10	0	0	0	0	0	0	0	0	0
COMD11	0	0	0	0	0	0	0	0	0
COMD12	0	0	0	0	0	0	0	0	0
COMD13	0	0	0	0	0	0	0	0	0
COMD14	0	0	0	0	0	0	0	0	0
COMD15	0	0	0	0	0	0	0	0	0
COMF1	0	0	0	0	0	0	0	0	0
COMF2	0	0	0	0	0	0	0	0	0
COMF3	0	0	0	0	0	0	0	0	0
COMF4	0	0	0	0	0	0	0	0	0
COMF5	0	0	0	0	0	0	0	0	0
COMF6	0	0	0	0	0	0	0	0	0
COMF7	0	0	0	0	0	0	0	0	0
COMF8	0	0	0	0	0	0	0	0	0
COMF9	0	0	0	0	0	0	0	0	0
COMF10	0	0	0	0	0	0	0	0	0
COMF11	0	0	0	0	0	0	0	0	0
COMF12	0	0	0	0	0	0	0	0	0
COMF13	0	0	0	0	0	0	0	0	0
COMF14	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	COMF4	COMF5	COMF6	COMF7	COMF8	COMF9	COMF10	COMF11	COMF12
COMF15	0	0	0	0	0	0	0	0	0
TTM1	0	0	0	0	0	0	0	0	0
ITAX1	0	0	0	0	0	0	0	0	0
SUBY1	0	0	0	0	0	0	0	0	0
HHH1	0	0	0	0	0	0	0	0	0
HHH2	0	0	0	0	0	0	0	0	0
HHH3	0	0	0	0	0	0	0	0	0
HHH4	0	0	0	0	0	0	0	0	0
HHH5	0	0	0	0	0	0	0	0	0
GOV1	0	0	0	0	0	0	0	0	0
POE1	0	0	0	0	0	0	0	0	0
SOE1	0	0	0	0	0	0	0	0	0
FIN1	0	0	0	0	0	0	0	0	0
ROW1	3985006	55946	12815	15807	3090	134026	18994	484	16112
KHHH1	0	0	0	0	0	0	0	0	0
KHHH2	0	0	0	0	0	0	0	0	0
KHHH3	0	0	0	0	0	0	0	0	0
KHHH4	0	0	0	0	0	0	0	0	0
KHHH5	0	0	0	0	0	0	0	0	0
KGOV1	0	0	0	0	0	0	0	0	0
KPOE1	0	0	0	0	0	0	0	0	0
KSOE1	0	0	0	0	0	0	0	0	0
KFIN1	0	0	0	0	0	0	0	0	0
KROW1	0	0	0	0	0	0	0	0	0
FINA1	0	0	0	0	0	0	0	0	0
FINA2	0	0	0	0	0	0	0	0	0
FINA3	0	0	0	0	0	0	0	0	0
FINA4	0	0	0	0	0	0	0	0	0
FINA5	0	0	0	0	0	0	0	0	0
FINA6	0	0	0	0	0	0	0	0	0
FINA7	0	0	0	0	0	0	0	0	0
FINA8	0	0	0	0	0	0	0	0	0
FINA9	0	0	0	0	0	0	0	0	0
FINA10	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	COMF13	COMF14	COMF15	TTM1	ITAX1	SUBY1	HHH1	HHH2	HHH3
FACT1	0	0	0	0	0	0	0	0	0
FACT2	0	0	0	0	0	0	0	0	0
FACT3	0	0	0	0	0	0	0	0	0
SEC1	0	0	0	0	0	0	0	0	0
SEC2	0	0	0	0	0	0	0	0	0
SEC3	0	0	0	0	0	0	0	0	0
SEC4	0	0	0	0	0	0	0	0	0
SEC5	0	0	0	0	0	0	0	0	0
SEC6	0	0	0	0	0	0	0	0	0
SEC7	0	0	0	0	0	0	0	0	0
SEC8	0	0	0	0	0	0	0	0	0
SEC9	0	0	0	0	0	0	0	0	0
SEC10	0	0	0	0	0	0	0	0	0
SEC11	0	0	0	0	0	0	0	0	0
SEC12	0	0	0	0	0	0	0	0	0
SEC13	0	0	0	0	0	0	0	0	0
SEC14	0	0	0	0	0	0	0	0	0
SEC15	0	0	0	0	0	0	0	0	0
COMD1	0	0	0	0	0	0	23855	35886	42702
COMD2	0	0	0	0	0	0	5235	7941	10709
COMD3	0	0	0	0	0	0	13	19	24
COMD4	0	0	0	0	0	0	123506	181961	240634
COMD5	0	0	0	0	0	0	4267	7659	12064
COMD6	0	0	0	0	0	0	15	37	56
COMD7	0	0	0	0	0	0	26604	49502	78576
COMD8	0	0	0	0	0	0	3089	6922	16974
COMD9	0	0	0	0	0	0	9761	18228	29273
COMD10	0	0	0	0	0	0	3151	6332	8819
COMD11	0	0	0	0	0	0	9027	14549	19386
COMD12	0	0	0	0	0	0	0	0	0
COMD13	0	0	0	0	0	0	1504	2643	3989
COMD14	0	0	0	0	0	0	6028	8244	10886
COMD15	0	0	0	0	0	0	2966	4806	9726
COMF1	0	0	0	0	0	0	0	0	0
COMF2	0	0	0	0	0	0	0	0	0
COMF3	0	0	0	0	0	0	0	0	0
COMF4	0	0	0	0	0	0	0	0	0
COMF5	0	0	0	0	0	0	0	0	0
COMF6	0	0	0	0	0	0	0	0	0
COMF7	0	0	0	0	0	0	0	0	0
COMF8	0	0	0	0	0	0	0	0	0
COMF9	0	0	0	0	0	0	0	0	0
COMF10	0	0	0	0	0	0	0	0	0
COMF11	0	0	0	0	0	0	0	0	0
COMF12	0	0	0	0	0	0	0	0	0
COMF13	0	0	0	0	0	0	0	0	0
COMF14	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	COMF13	COMF14	COMF15	TTM1	ITAX1	SUBY1	HHH1	HHH2	HHH3
COMF15	0	0	0	0	0	0	0	0	0
TTM1	0	0	0	0	0	0	0	0	0
ITAX1	0	0	0	0	0	0	0	0	0
SUBY1	0	0	0	0	0	0	0	0	0
HHH1	0	0	0	0	0	0	0	0	0
HHH2	0	0	0	0	0	0	0	0	0
HHH3	0	0	0	0	0	0	0	0	0
HHH4	0	0	0	0	0	0	0	0	0
HHH5	0	0	0	0	0	0	0	0	0
GOV1	0	0	0	0	812202	0	5506	8923	18059
POE1	0	0	0	0	0	0	0	0	0
SOE1	0	0	0	0	0	0	0	0	0
FIN1	0	0	0	0	0	0	0	0	0
ROW1	66	284	215253	0	0	0	0	0	0
KHHH1	0	0	0	0	0	0	-16156	0	0
KHHH2	0	0	0	0	0	0	0	-8147	0
KHHH3	0	0	0	0	0	0	0	0	8997
KHHH4	0	0	0	0	0	0	0	0	0
KHHH5	0	0	0	0	0	0	0	0	0
KGOV1	0	0	0	0	0	0	0	0	0
KPOE1	0	0	0	0	0	0	0	0	0
KSOE1	0	0	0	0	0	0	0	0	0
KFIN1	0	0	0	0	0	0	0	0	0
KROW1	0	0	0	0	0	0	0	0	0
FINA1	0	0	0	0	0	0	0	0	0
FINA2	0	0	0	0	0	0	0	0	0
FINA3	0	0	0	0	0	0	0	0	0
FINA4	0	0	0	0	0	0	0	0	0
FINA5	0	0	0	0	0	0	0	0	0
FINA6	0	0	0	0	0	0	0	0	0
FINA7	0	0	0	0	0	0	0	0	0
FINA8	0	0	0	0	0	0	0	0	0
FINA9	0	0	0	0	0	0	0	0	0
FINA10	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	HHH4	HHH5	GOV1	POE1	SOE1	FIN1	ROW1	KHHH1	KHHH2
FACT1	0	0	0	0	0	0	0	0	0
FACT2	0	0	0	0	0	0	0	0	0
FACT3	0	0	0	0	0	0	0	0	0
SEC1	0	0	0	0	0	0	0	0	0
SEC2	0	0	0	0	0	0	0	0	0
SEC3	0	0	0	0	0	0	0	0	0
SEC4	0	0	0	0	0	0	0	0	0
SEC5	0	0	0	0	0	0	0	0	0
SEC6	0	0	0	0	0	0	0	0	0
SEC7	0	0	0	0	0	0	0	0	0
SEC8	0	0	0	0	0	0	0	0	0
SEC9	0	0	0	0	0	0	0	0	0
SEC10	0	0	0	0	0	0	0	0	0
SEC11	0	0	0	0	0	0	0	0	0
SEC12	0	0	0	0	0	0	0	0	0
SEC13	0	0	0	0	0	0	0	0	0
SEC14	0	0	0	0	0	0	0	0	0
SEC15	0	0	0	0	0	0	0	0	0
COMD1	52885	72589	1313	0	0	0	80559	29	59
COMD2	14545	20699	530	0	0	0	2062	0	0
COMD3	32	44	0	0	0	0	47636	1	1
COMD4	347648	724783	77098	0	0	0	4744667	23562	47124
COMD5	21004	39100	18208	0	0	0	15798	0	0
COMD6	87	120	1944	0	0	0	11862	8186	16371
COMD7	154173	311417	13932	0	0	0	39818	4998	9997
COMD8	50101	173720	10252	0	0	0	104340	0	0
COMD9	58678	128378	15851	0	0	0	384451	817	1635
COMD10	14627	61745	1345	0	0	0	7508	0	0
COMD11	32510	68067	1	0	0	0	21192	347	693
COMD12	0	0	301482	0	0	0	5444	0	0
COMD13	7527	12825	286207	0	0	0	57	0	0
COMD14	16189	29759	97263	0	0	0	18728	0	0
COMD15	16383	55117	16841	0	0	0	243045	0	0
COMF1	0	0	0	0	0	0	0	0	0
COMF2	0	0	0	0	0	0	0	0	0
COMF3	0	0	0	0	0	0	0	0	0
COMF4	0	0	0	0	0	0	0	0	0
COMF5	0	0	0	0	0	0	0	0	0
COMF6	0	0	0	0	0	0	0	0	0
COMF7	0	0	0	0	0	0	0	0	0
COMF8	0	0	0	0	0	0	0	0	0
COMF9	0	0	0	0	0	0	0	0	0
COMF10	0	0	0	0	0	0	0	0	0
COMF11	0	0	0	0	0	0	0	0	0
COMF12	0	0	0	0	0	0	0	0	0
COMF13	0	0	0	0	0	0	0	0	0
COMF14	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	HHH4	HHH5	GOV1	POE1	SOE1	FIN1	ROW1	KHHH1	KHHH2
COMF15	0	0	0	0	0	0	0	0	0
TTM1	0	0	0	0	0	0	0	0	0
ITAX1	0	0	0	0	0	0	0	0	0
SUBY1	0	0	0	0	0	0	0	0	0
HHH1	0	0	0	0	71846	0	0	0	0
HHH2	0	0	0	0	67247	0	0	0	0
HHH3	0	0	0	0	58285	0	0	0	0
HHH4	0	0	0	0	39112	0	0	0	0
HHH5	0	0	0	0	-265809	0	0	0	0
GOV1	30419	102339	0	0	356731	0	0	0	0
POE1	0	0	0	0	0	0	0	0	0
SOE1	0	0	0	0	0	0	-920263	0	0
FIN1	0	0	100465	0	-26908	0	0	0	0
ROW1	0	0	0	0	0	0	0	0	0
KHHH1	0	0	0	0	0	0	0	0	0
KHHH2	0	0	0	0	0	0	0	0	0
KHHH3	0	0	0	0	0	0	0	0	0
KHHH4	24268	0	0	0	0	0	0	0	0
KHHH5	0	276508	0	0	0	0	0	0	0
KGOV1	0	0	460124	0	0	0	0	0	0
KPOE1	0	0	0	0	1017534	0	0	0	0
KSOE1	0	0	0	0	0	0	0	0	0
KFIN1	0	0	0	0	0	73557	0	0	0
KROW1	0	0	0	0	0	0	311085	0	0
FINA1	0	0	0	0	0	0	0	641	1602
FINA2	0	0	0	0	0	0	0	8381	20953
FINA3	0	0	0	0	0	0	0	0	0
FINA4	0	0	0	0	0	0	0	0	0
FINA5	0	0	0	0	0	0	0	0	0
FINA6	0	0	0	0	0	0	0	0	0
FINA7	0	0	0	0	0	0	0	0	0
FINA8	0	0	0	0	0	0	0	0	0
FINA9	0	0	0	0	0	0	0	0	0
FINA10	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	KHHH3	KHHH4	KHHH5	KGOV1	KPOE1	KSOE1	KFIN1	KROW1	FINA1
FACT1	0	0	0	0	0	0	0	0	0
FACT2	0	0	0	0	0	0	0	0	0
FACT3	0	0	0	0	0	0	0	0	0
SEC1	0	0	0	0	0	0	0	0	0
SEC2	0	0	0	0	0	0	0	0	0
SEC3	0	0	0	0	0	0	0	0	0
SEC4	0	0	0	0	0	0	0	0	0
SEC5	0	0	0	0	0	0	0	0	0
SEC6	0	0	0	0	0	0	0	0	0
SEC7	0	0	0	0	0	0	0	0	0
SEC8	0	0	0	0	0	0	0	0	0
SEC9	0	0	0	0	0	0	0	0	0
SEC10	0	0	0	0	0	0	0	0	0
SEC11	0	0	0	0	0	0	0	0	0
SEC12	0	0	0	0	0	0	0	0	0
SEC13	0	0	0	0	0	0	0	0	0
SEC14	0	0	0	0	0	0	0	0	0
SEC15	0	0	0	0	0	0	0	0	0
COMD1	73	176	439	193	410	0	0	277	0
COMD2	0	0	0	0	0	0	0	0	0
COMD3	2	4	11	5	10	0	0	7	0
COMD4	58906	141373	353433	155729	330453	0	0	223259	0
COMD5	0	0	0	0	0	0	0	0	0
COMD6	20464	49113	122783	54100	114799	0	0	77560	0
COMD7	12496	29990	74976	33036	70101	0	0	47361	0
COMD8	0	0	0	0	0	0	0	0	0
COMD9	2044	4905	12262	5403	11465	0	0	7746	0
COMD10	0	0	0	0	0	0	0	0	0
COMD11	867	2080	5200	2291	4862	0	0	3285	0
COMD12	0	0	0	0	0	0	0	0	0
COMD13	0	0	0	0	0	0	0	0	0
COMD14	0	0	0	0	0	0	0	0	0
COMD15	0	0	0	0	0	0	0	0	0
COMF1	0	0	0	0	0	0	0	0	0
COMF2	0	0	0	0	0	0	0	0	0
COMF3	0	0	0	0	0	0	0	0	0
COMF4	0	0	0	0	0	0	0	0	0
COMF5	0	0	0	0	0	0	0	0	0
COMF6	0	0	0	0	0	0	0	0	0
COMF7	0	0	0	0	0	0	0	0	0
COMF8	0	0	0	0	0	0	0	0	0
COMF9	0	0	0	0	0	0	0	0	0
COMF10	0	0	0	0	0	0	0	0	0
COMF11	0	0	0	0	0	0	0	0	0
COMF12	0	0	0	0	0	0	0	0	0
COMF13	0	0	0	0	0	0	0	0	0
COMF14	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	KHHH3	KHHH4	KHHH5	KGOV1	KPOE1	KSOE1	KFIN1	KROW1	FINA1
COMF15	0	0	0	0	0	0	0	0	0
TTM1	0	0	0	0	0	0	0	0	0
ITAX1	0	0	0	0	0	0	0	0	0
SUBY1	0	0	0	0	0	0	0	0	0
HHH1	0	0	0	0	0	0	0	0	0
HHH2	0	0	0	0	0	0	0	0	0
HHH3	0	0	0	0	0	0	0	0	0
HHH4	0	0	0	0	0	0	0	0	0
HHH5	0	0	0	0	0	0	0	0	0
GOV1	0	0	0	0	0	0	0	0	0
POE1	0	0	0	0	0	0	0	0	0
SOE1	0	0	0	0	0	0	0	0	0
FIN1	0	0	0	0	0	0	0	0	0
ROW1	0	0	0	0	0	0	0	0	0
KHHH1	0	0	0	0	0	0	0	0	0
KHHH2	0	0	0	0	0	0	0	0	0
KHHH3	0	0	0	0	0	0	0	0	0
KHHH4	0	0	0	0	0	0	0	0	0
KHHH5	0	0	0	0	0	0	0	0	0
KGOV1	0	0	0	0	0	0	0	0	0
KPOE1	0	0	0	0	0	0	0	0	0
KSOE1	0	0	0	0	0	0	0	0	24754
KFIN1	0	0	0	0	0	0	0	0	0
KROW1	0	0	0	0	0	0	0	0	0
FINA1	3525	4806	8651	-1032	0	0	6560	0	0
FINA2	46098	62860	113149	103815	180445	27085	-8218	0	0
FINA3	0	0	0	0	-82364	0	468424	79533	0
FINA4	0	0	174996	0	50926	5915	-29501	10446	0
FINA5	0	0	28611	0	122810	-4056	-44706	68955	0
FINA6	0	0	173543	0	292392	-1087	113284	225715	0
FINA7	0	0	-13260	0	-110536	268236	98606	0	0
FINA8	0	0	-277717	0	0	0	0	0	0
FINA9	0	0	0	285396	-34231	8812	48731	-211622	0
FINA10	0	0	0	0	0	189788	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	FINA2	FINA3	FINA4	FINA5	FINA6	FINA7	FINA8	FINA9	FINA10
FACT1	0	0	0	0	0	0	0	0	0
FACT2	0	0	0	0	0	0	0	0	0
FACT3	0	0	0	0	0	0	0	0	0
SEC1	0	0	0	0	0	0	0	0	0
SEC2	0	0	0	0	0	0	0	0	0
SEC3	0	0	0	0	0	0	0	0	0
SEC4	0	0	0	0	0	0	0	0	0
SEC5	0	0	0	0	0	0	0	0	0
SEC6	0	0	0	0	0	0	0	0	0
SEC7	0	0	0	0	0	0	0	0	0
SEC8	0	0	0	0	0	0	0	0	0
SEC9	0	0	0	0	0	0	0	0	0
SEC10	0	0	0	0	0	0	0	0	0
SEC11	0	0	0	0	0	0	0	0	0
SEC12	0	0	0	0	0	0	0	0	0
SEC13	0	0	0	0	0	0	0	0	0
SEC14	0	0	0	0	0	0	0	0	0
SEC15	0	0	0	0	0	0	0	0	0
COMD1	0	0	0	0	0	0	0	0	0
COMD2	0	0	0	0	0	0	0	0	0
COMD3	0	0	0	0	0	0	0	0	0
COMD4	0	0	0	0	0	0	0	0	0
COMD5	0	0	0	0	0	0	0	0	0
COMD6	0	0	0	0	0	0	0	0	0
COMD7	0	0	0	0	0	0	0	0	0
COMD8	0	0	0	0	0	0	0	0	0
COMD9	0	0	0	0	0	0	0	0	0
COMD10	0	0	0	0	0	0	0	0	0
COMD11	0	0	0	0	0	0	0	0	0
COMD12	0	0	0	0	0	0	0	0	0
COMD13	0	0	0	0	0	0	0	0	0
COMD14	0	0	0	0	0	0	0	0	0
COMD15	0	0	0	0	0	0	0	0	0
COMF1	0	0	0	0	0	0	0	0	0
COMF2	0	0	0	0	0	0	0	0	0
COMF3	0	0	0	0	0	0	0	0	0
COMF4	0	0	0	0	0	0	0	0	0
COMF5	0	0	0	0	0	0	0	0	0
COMF6	0	0	0	0	0	0	0	0	0
COMF7	0	0	0	0	0	0	0	0	0
COMF8	0	0	0	0	0	0	0	0	0
COMF9	0	0	0	0	0	0	0	0	0
COMF10	0	0	0	0	0	0	0	0	0
COMF11	0	0	0	0	0	0	0	0	0
COMF12	0	0	0	0	0	0	0	0	0
COMF13	0	0	0	0	0	0	0	0	0
COMF14	0	0	0	0	0	0	0	0	0

Financial Social Accounting Matrix of Thailand in 2007 (Continued)

Sector	FINA2	FINA3	FINA4	FINA5	FINA6	FINA7	FINA8	FINA9	FINA10
COMF15	0	0	0	0	0	0	0	0	0
TTM1	0	0	0	0	0	0	0	0	0
ITAX1	0	0	0	0	0	0	0	0	0
SUBY1	0	0	0	0	0	0	0	0	0
HHH1	0	0	0	0	0	0	0	0	0
HHH2	0	0	0	0	0	0	0	0	0
HHH3	0	0	0	0	0	0	0	0	0
HHH4	0	0	0	0	0	0	0	0	0
HHH5	0	0	0	0	0	0	0	0	0
GOV1	0	0	0	0	0	0	0	0	0
POE1	0	0	0	0	0	0	0	0	0
SOE1	0	0	0	0	0	0	0	0	0
FIN1	0	0	0	0	0	0	0	0	0
ROW1	0	0	0	0	0	0	0	0	0
KHHH1	0	15792	0	0	0	0	0	47326	0
KHHH2	0	31583	0	0	0	0	0	75000	0
KHHH3	0	42111	0	0	0	0	0	93365	0
KHHH4	0	57903	0	0	0	0	0	213137	0
KHHH5	0	347417	0	0	0	0	0	153151	0
KGOV1	0	-30213	209026	0	0	0	0	0	0
KPOE1	-68559	31583	0	77302	585830	-35394	-302812	-353944	0
KSOE1	0	-42685	0	56052	218016	277773	-49099	9881	0
KFIN1	623128	12102	3755	38259	0	-30981	74193	-140831	0
KROW1	0	0	0	0	0	31649	0	0	189788
FINA1	0	0	0	0	0	0	0	0	0
FINA2	0	0	0	0	0	0	0	0	0
FINA3	0	0	0	0	0	0	0	0	0
FINA4	0	0	0	0	0	0	0	0	0
FINA5	0	0	0	0	0	0	0	0	0
FINA6	0	0	0	0	0	0	0	0	0
FINA7	0	0	0	0	0	0	0	0	0
FINA8	0	0	0	0	0	0	0	0	0
FINA9	0	0	0	0	0	0	0	0	0
FINA10	0	0	0	0	0	0	0	0	0

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